

Government of Lao PDR



Asian Development Bank

CUMULATIVE IMPACT ANALYSIS

AND NAM THEUN 2 CONTRIBUTIONS

FINAL REPORT

OCTOBER 2004

EcoLao

NORPLAN 



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ANALYSIS AND NAM THEUN 2 CONTRIBUTIONS

FINAL REPORT

October 2004

Date of issue : 15.10.04
Prepared by : NORPLAN and EcoLao
Checked by : Stephen Sparkes
Approved by : Erik Børset

EXECUTIVE SUMMARY

Background and Analytic Process

The Nam Theun 2 (NT2) Hydropower Project is the largest infrastructure development project in Lao People's Democratic Republic (PDR). As a result of the potential impacts the project may have on the development of the area, international funding institutions have requested a Cumulative Impact Assessment (CIA) in order to analyse the combined impacts of a number of projects, either implemented together or in a sequence and of future developments and plans, in relation to NT2. The CIA includes:

- Effects other (future) developments in the area have on the type and magnitude of the NT2 impacts. (Added impacts)
- Impacts of development in other sectors that are induced by NT2 activities and its supplementary components. (Induced impacts)

The primary geographic areas covered are the Mekong Basin, Nam Kading, Xe Bangfai and Hinboun basins and the linear development zone of the transmission lines and roads. In addition, border areas are covered in relation to social development, transport and biodiversity.

Two development scenarios are presented based on a 5-year and 20-year planning horizon. These scenarios cover a number of sectors by examining the present situation, existing plans and development trends. Sectors covered are: hydropower, transport, irrigation, water supply and sanitation, urban development, fisheries, forestry, industry, social development (including ethnic minorities, health, education and social disparity), and conservation (biodiversity issues).

The anticipated output from the CIA is a comprehensive understanding of the cumulative impacts of the NT2 Project in the regional context. In addition, the CIA will form part of the ongoing consultation process with stakeholders for detailing interventions and, perhaps, serve as a model for future CIA studies of large infrastructure projects.

Administrative and Legal Framework

The planning and future implementation of the NT2 Project conforms to both the Lao national legal requirements and policy, and the safeguard policies and guidelines of the ADB, WBG and other financing institutions. The basic legal framework consists of the Environmental Protection Law and other key legislation covering forestry, water management, land use and resettlement. A number of technical assistance projects have assisted GoL over the past 15 years to establish new laws, policies and guidelines that meet the requirements of international donor organisations.

Lao PDR is committed to the provisions outlined in a number of international conventions and treaties. This includes the Agreement on the Cooperation for Sustainable Development of the Mekong River Basin (Mekong River Commission), the Convention on Biological Diversity (CDB), the Convention on the Protection of World Cultural and Natural Heritage and the Convention on International Trade in Endangered Species (CITES).

Requirements and safeguard policies of the ADB and WBG have also played a key role in the planning of NT2. In particular guidelines on environmental assessment, natural habitats, involuntary resettlement, indigenous people, cultural property, dam safety and international waterways. An extensive consultation process has been undertaken with all stakeholders in accordance with donor requirements.

NT2 Project and its Predicted Impacts

The key technical features of the NT2 Project include a 48 m high dam on the Nam Theun creating a reservoir covering an area of 450 km² in the wet season. Water will be diverted through a headrace tunnel to a powerhouse located on the Gnommalath Plain where it will be discharged into a channel and into the Xe Bangfai. A catchment area of 4,013 km² will supply the reservoir with water of good quality during the wet season. Minimum bypass flow from the dam will be 2 m³/s, reducing existing flow along the Nam Kading. Discharged water from the power plant will double the flow during the dry season and add about 10% in the wet season in the Xe Bangfai. The total installed capacity will be 1074 MW.

From a social and environmental point of view the key mitigation actions and management interventions will consist of:

- Resettlement of about 5000 ethnic minorities on the Nakai Plateau to resettlement villages and a rehabilitation plan promoting new livelihood systems.
- Forestry and Fisheries management plans for resettlers.
- Impacts from the construction and running of four camps with approximately accommodation for 4200 workers.
- Health and education plans and capacity building for existing government organisations and organisations created specifically to mitigate the effects of the NT2.
- Measures to regulate and restrict release in the Xe Bangfai, restrict erosion and sedimentation, construction of an aeration weir and other measures to mitigate changes in water quality and water flow.
- Infrastructure improvements for existing provincial roads and new access roads.
- Social and environmental management plan for the NT2 Catchment (Nakai-Nam Theun NBCA) to introduce conservation measures to preserve biodiversity and promote sustainable socio-economic development.

Assumed Sector Developments

Sector developments are based on an analysis of existing development trends and plans with an emphasis on aspects that may combine with impacts caused by the NT2 Project.

Hydropower is the most planned sector with long-term development plans for the region. Hydropower development in Yunnan Province in PR China is likely to have the greatest impact on hydrology in the Mekong Basin with a potential installed capacity of 15,600 MW and active storage of 23,200 mill.m³ by 2025. A number of projects are planned in Lao PDR, of which NT2 is the largest. No significant hydropower development is planned for Thailand. It is unlikely that Cambodia will develop larger project in the Mekong Basin in the next 20 years and only a few projects are planned on Vietnam tributaries. NT2 will account for 12% (2010) and 7% (2025) of the active storage capacity in the Mekong Basin. In terms of kW per m³, the Chinese projects produce about four times more power compared to the planned projects in Lao PDR.

Transport is a dynamic growth sector and potentially a key factor in the reduction of poverty and socio-economic development in Lao PDR and the region. Considerable funds are being channelled into this sector with the goal of linking all major towns in the country. There are plans for several important transportation corridors linking Lao PDR to Thailand and Vietnam,

including the East-West Corridor (Route 9), with a bridge at Savannakhet, Route 8 in Bolikhamxai to the Vietnamese border and Route 12 in Khammouane. Many of these roads link up with roads to be upgraded by the NT2 Project.

Irrigation development depends on availability of funds, proper management and technological level and standards. By far the largest and most intensively cultivated irrigated dry season rice areas are found in the Mekong Delta. By 2000 these double-cropped areas constituted around 87% of the total area of dry season irrigated rice in the Mekong Basin. Lao PDR and Cambodia, where a doubling appears possible, have the largest percentage wise expansion potential for dry season irrigated rice. From the local perspective, the Xe Bangfai Basin has the largest potential where more than a 50% expansion of dry season irrigated area may be possible.

Water supply and sanitation are linked to growing demand due to population increase and urbanisation. Estimates for increased water consumption show a need for three times the existing supply by 2025 when up to 80 million people may inhabit the Lower Mekong Basin, up from 55 million at present. In the NT2 Project area, several towns have plans to expand or establish water supply and sanitation projects to cope with growing demand.

Urban development trends in the local context are concerned with population increase due mainly to in-migration from rural areas or from outside of the Project area to the towns of Thakhek, Mahaxai and Gnommalath in Khammouane Province and Lak Xao in Bolikhamxai. Along with urbanisation come the challenges of town planning, water supply and sanitation.

Fisheries are a key development sector both locally and in the Mekong region. Future hydro-power development and subsequent changes in water flow and water quality will affected this sector in the short and long-term. At present in the Lower Mekong Basin, fish and aquaculture yields are increasing but this may not be sustainable with present methods and technology. The NT2 reservoir is expected to give rise to new fisheries.

Forestry concerns both commercial logging and utilisation of forests used by local communities for harvesting of NTFPs and traditional products. Forest cover in the Mekong Basin is dwindling with an estimated total cover of 34.4%, Lao PDR having approximately 40%, which is likely to decline to 30% given the present trends. Commercial logging in the Project Area has been extensive and there is currently overcapacity in the timber-processing sector. A number of plans deal with reforestation and the establishment of plantations.

Industry as a sector is concentrated in towns, the most important in the Project Area being Savannakhet where there are a number of light industries established. Wood processing is the most important industry in Bolikhamxai and Khammouane Provinces. Potential industries being developed are oil refineries, textiles, canning and construction materials.

Mining is developing rapidly in the Lao PDR and may lead to increased pollution and wastewater discharges. Tin, zinc and lead are being extracted in the Nam Pathen Valley on a tributary of the Nam Hinboun and this may be contributing to increased turbidity and heavy metal concentrations in the water. Some gypsum mining in Donghene District and large-scale mining of gold and copper are taking place in Xepon District, Savannakhet. Further developments in the future may prove to be economically viable.

Social Development covers a number of sub-sectors or themes: health, education, ethnic minorities and social disparity. In terms of health and education, the existing services are weak in terms of lack of skills, materials, equipment and funding. The spread of HIV/AIDS and other STIs is of concern as mobility, urbanisation and in-migration increase. There is also a trend toward increased social disparity between households in communities (advantages of human, material and financial resources lead to advantages in employment opportunities),

between rural and urban areas (growing gap in services and wealth) and between men and women (trends favour men) due. In addition, ethnic minorities are being integrated and assimilated and lose their cultural identity as a result of socio-economic change, cultural contact and loss of traditional livelihoods.

Conservation is a key issue since there are several areas in the Project Area that are classified as having very high biodiversity value for SE Asia, in particular the Nakai - Nam Theun NBCA and the Vu Quang National Park in Vietnam. There have been a number of positive developments in terms of policy, ratification of international agreements and conventions, the establishment of 20 NBCAs and the development of conservation management plans. However, there are clear trends that illegal hunting and trading in wildlife is seriously threatening many endangered species and the biodiversity of many NBCAs. Enforcement of laws and regulations is weak.

Impact Zones

The study distinguishes between five main zones in order to present the analysis of scenarios in a systematic manner:

- Nakai Plateau– area dominated by NT2 Project activities in Nakai District, Khammouane Province
- Nakai-Nam Theun NBCA covering a large part of the Nam Theun catchment.
- Xe Bangfai Basin and surrounding downstream areas covering most of Khammouane and Savannakhet Provinces in Lao PDR
- Nam Theun/Nam Kading and Nam Hinboun Basins and surrounding areas covering a number of districts in Bolikhamxai Province, including Khamkheut (Lak Xao)
- Mekong Basin covering the mainstream Mekong from the mouth of the Nam Kading to the Mekong Delta, including the Great Lake.

Predictions of Cumulative Impacts

The tables on the following pages give a brief summary of the predictions of cumulative impacts as identified for the different impact zones.

Summary of Cumulative Impacts for the Nakai Plateau Impact Zone

Nakai Plateau	
5-year scenario	20-year scenario
<p>The impacts will be dominated by NT2 project activities. Some additional impacts are however, envisaged due to improved access and activities “following” the construction work and temporary population increase.</p> <p>The most important impacts will be increased pressure on wildlife, increased risk for STIs including HIV/AIDS and increasing frequency and severity of vehicular accidents.</p>	<p>The situation will have stabilised but will have changed significantly compared to the initial situation. Communication both north and south will be radically improved and the reservoir will have attracted new activities like commercial fisheries and tourism. It is assumed that:</p> <ul style="list-style-type: none"> • Sanitation and water supply will be improved. • The Odomsouk population will possibly have increased with more than 180% in relation to number of inhabitants before the start of construction activities.

	<ul style="list-style-type: none"> • Commercial fisheries will be established. • The health conditions will be improved with reduced incidence of malaria and food and water borne diseases, and there will be a shift from communicable towards non-communicable diseases. • Health and education services will be struggling to keep up with demand due to population increase. • There will be increased employment in service sector including tourism. • There will be increased cultural integration on the Plateau with blurring of ethnic borders and loss of identity.
--	--

Summary of Cumulative Impacts for the Nakai-Nam Theun NBCA Impact Zone

Nakai-Nam Theun NBCA	
5-year scenario	20-year scenario
<ul style="list-style-type: none"> • Migration of fish from the Nam Theun affected by the establishment of the reservoir • Better protection of biodiversity and forest resources through SEMFOP while at the same time threats to biodiversity will come from extractive activities and hunting linked to developments on the Vietnamese side of the border including road building and increased population. • Improved social service delivery in terms of availability of medicines, possible reductions of malaria and nutritional problems, improved access to education. • Some integration of ethnic minorities and adoption of elements from dominant lowland Lao culture but not to the same extent as with the Plateau communities • Some improvement in terms of poverty alleviation. 	<ul style="list-style-type: none"> • Effect on fish biodiversity and production will depend on whether the development of reservoir fish population become dominated by small pelagic species confined to the reservoir or by larger species using the tributaries in the NBCA for breeding. • Increased threat to biodiversity through population increases on the Vietnamese side of the border leading to increased exploitation of the NBCA • Further improvements in social services including immunisation coverage, hygiene and nutrition, health centres and functioning village schools. • Natural population increase will result in considerable out-migration and labour migration to urban areas for shorter or longer periods. • The process of integration with the lowland Lao culture will have proceeded further and led to assimilation of small Vietic groups. • Significant reduction of poverty in terms of food security, better market access and employment opportunities.

Summary of Cumulative Impacts for the Xe Bangfai Basin and Surrounding Districts Impact Zone

Xe Bangfai Basin and Surrounding Districts	
5-year scenario	20-year scenario
<p>The impacts of the NT2 operation will have started to be felt. In addition, the new Road 12 will have significant impacts. The cumulative impacts are likely to be:</p> <ul style="list-style-type: none"> • Increase in untreated wastewater due to population increase around Gnommalath and Mahaxai may add to the oxygen depletion problems caused by the reservoir and make the water less fit for consumption and fish production. • Higher pressure on biodiversity in terms of hunting and logging due to influx of people and improved access to the area. Improved management and enforcement efforts in the Nakai Nam Theun NBCA might increase the pressure on other NBCAs. • There will be commercialisation and intensification of agriculture in Mahaxai and Gnommalath, but the irrigated rice area will yet only be moderately expanded. • Logging in undisturbed forest and other areas will increase • Gnommalath and Mahaxai urban areas will expand considerably, possibly experiencing a doubling of the population while ad hoc planning will characterises the expansion of settlements. • STI and HIV/AIDS prevalence will have increased and vehicular accidents will have become more common. • The capacity of the various district services will have been strengthened considerably due to NT2 Project support. 	<p>No new large-scale hydrological changes are foreseen, but the transport corridors and accompanying urbanisation will be a significant development in relation to cumulative impacts. In summary the impacts are likely to be:</p> <ul style="list-style-type: none"> • The oxygen depletion problem will be reduced due to less organic matter in the reservoir and better wastewater treatment. • Agriculture development will cause local eutrophication problems and heightened levels of pesticides in drainage water, consequently in fish might be experienced. • Change in flow regime may have lowered biodiversity and fish production due to disturbed spawning cycles. On the other hand increased flooding may have increased flood plain and “back swamps” production of fish. • There will be better sanitation, health services and improved awareness on health issues. Water-borne illnesses and intestinal parasitic infestations will have been substantially reduced as will mortality caused by malaria and dengue fever. • The District centres of Mahaxai and Gnommalath will have grown substantially, possibly with more than 200% while the population of Thakhek may have increased with more than 140%. The service sector including tourism will grow and the cement industry in Mahaxai will have expanded and created more employment. • Some assimilation of ethnic minority groups in urban areas will have occurred, but cultural identity will to at larger extent be retained in rural areas.

Summary of Cumulative Impacts for the Nam Theun, Nam Kading and Nam Hinboun Basin and Surrounding Districts Impact Zone

Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts	
5-year scenario	20-year scenario
<p>Nam Kading and Nam Hinboun will experience the combined impacts of the NT2 and the Theun-Hinboun Extension projects, in addition to the developments caused by the improvement of the Route 8 corridor, and increase in cross-border trade and population movement. The predicted impacts are:</p> <ul style="list-style-type: none"> • In Nam Kading downstream Theun-Hinboun dam, the impact from NT2 will reduce the discharge in the flood season. Adding Theun-Hinboun Extension, the cumulative impact will be that a larger part of the flood spills over Theun-Hinboun dams will be diverted into the Nam Hinboun, thereby further reducing the spills into the Nam Kading. • The reduction in flood periods will affect fish migratory behaviour and will probably make any ascent by migratory fish (not very significant at present) past the Theun-Hinboun dam impossible. • There will be increased threats to biodiversity due to population increase and increased trans-border traffic. However, the WCS wild-life conservation project will tend to counteract the negative development trend. • The remaining and limited forested areas will be increasingly encroached upon but participatory village forestry will have been introduced. • Irrigated areas and irrigation schemes will increase along Nam Hinboun. • Lak Xao will increase to a population of 17,000 – 18,000, representing a growth of more than 33% in relation to present number of inhabitants. Part of the growth will be due to in-migration. • Gradual integration of ethnic groups into the mainstream economy will speed up slightly due to NT2 project-related activities, population influx, increased urbanisation, improved infrastructure and growth in the service sector. • The vulnerable Vietic groups will be under particular pressure of integration. 	<p>No additional hydropower expansion is planned in the basin. The development will be dominated by the increase in transport related activities and impacts and developments on the Plateau. The main impacts will be:</p> <ul style="list-style-type: none"> • Nam Kading NBCA, Phou Hin Poun NBCA and Nam Chat/Nam Pan Provincial Conservation Forest are likely to experience an increased pressure of cultivation, logging and hunting as a result of improved protection of Nakai Nam Theun NBCA. • The rural urban migration trend will be reinforced and the size of Lak Xao will have grown to 27,000 –28,000, an increase of more than 110% compared to today's population. • It is likely that smaller ethnic groups in or near Lak Xao, including some Vietic populations, will be fully assimilated and will lose their ethnic identity. • Hmong cultural traditions and language are likely to continue despite changes in the socio-economic conditions in the area.

Summary of Cumulative Impacts for the Mekong River Basin Impact Zone

Mekong River Basin (Includes the impacts of planned hydropower developments in all GMS countries)	
5-year scenario	20-year scenario
<p>The dominant factor will be some additional development of hydropower in Yunnan and Lao PDR. The impacts and are calculated to be:</p> <ul style="list-style-type: none"> • Dry season discharge at Savannakhet may increase by 70% corresponding to a water level increase of 65 cm. During floods, the discharges may be reduced by around 10% corresponding to a reduction of water levels by 85 cm. • At Kratie the average annual maximum flow will be reduced from the present baseline of 35,250 m³/s to 33,565 m³/s (5%). • At the Tonle Sap River confluence (Phnom Penh) the water level will be reduced by about 25 cm during floods and increased by about 28 cm in the dry season. The Great Lake responds to the Mekong changes by lowering the average annual maximum level of the lake by 22 cm, compared to an annual variation in maximum level of about 2,5 – 3 m. • The changes in flow pattern will have a small negative impact on floodplain and Great Lake fisheries as these are favoured by high wet season water levels. • The changes in flow pattern will, however, have a small positive impact by damping damaging flood incidents and by the increased dry season water level that will support irrigation and reduce salt intrusion in Mekong Delta. 	<p>The dominant factor will be further development of hydropower in Yunnan and Lao PDR. The impacts and are calculated to be:</p> <ul style="list-style-type: none"> • Dry season discharge at Savannakhet may increase by 135% corresponding to a water level increase of 1.2 m. During floods, the discharges may be reduced by around 20% corresponding to a reduction of water levels by 1.6 m. • At Kratie the average annual maximum flow will be reduced from the present baseline of 35,250 m³/s to 31,020 m³/s (12%). • At the Tonle Sap River confluence (Phnom Penh) the water level will be reduced by about 60 cm during floods and increased by about 70 cm in the dry season. The Great Lake responds to the Mekong changes by lowering the average annual maximum level of the lake by 54 cm, compared to an annual variation in maximum level of about 2,5 – 3 m. • The changes in flow pattern will have a significant negative impact on floodplain and Great Lake fisheries as these are favoured by high wet season water levels. • The changes in flow pattern will, however, have a significant positive impact by damping damaging flood incidents and by the increased dry season water level that will support irrigation and reduce salt intrusion in Mekong Delta.

In addition to the predicted cumulative impacts, as shown in the tables above, also the specific impacts of the NT2 project, on downstream Mekong conditions has been calculated. It should be noted that assessment of the NT2 induced impact downstream is undertaken to determine whether or not such impacts have significant impact on the long-term sustainability of the ecological system downstream. In this context, the significance is determined based on whether or not the induced impacts are within the range of normal fluctuation.

The results are as follow:

- Between Pakhinbound and Xe Bangfai outlet there will be a reduction in both dry season (about 2 cm) and wet season (23 –29 cm) water level. The increased pumping cost for dry season irrigation will not be measurable. The reduced wet season level will have a positive impact by reduce flooding of the flood prone and highly developed agricultural land on the Thai side of the river.

- At the Tonle Sap River confluence, the Mekong water levels may be increased by about 2-3 cm in the dry season (from elevation 0.8 masl) and reduced by around 3 cm during floods (from elevation 8 masl).
- The Great Lake responds to the Mekong changes by lowering the wet season water level in the Great Lake by about 1% of the normal year-to-year fluctuation in wet season flood level. Therefore, NT2 impact on all aspects of the Great Lake including the fish production is considered "insignificant".
- The construction of the NT2 reservoir will cause only minimal retention of sediments and thus not have any significant impact on Mekong sediment balance.
- The changes in flow pattern will have an insignificant negative impact on floodplain and Great Lake fisheries, which are favoured by high wet season water levels.
- The changes in flow pattern will have a positive but insignificant impact by damping damaging flood incidents and by the increased dry season water level that will support irrigation and reduce salt intrusion in the Mekong Delta.

Recommendations and Interventions

The table below summarises the recommended mitigation and compensatory activities and initiative described in section 8.2 and assessments of their impacts in the 5-year and 20-year perspective. The impacts identified in Chapter 7 combined or modified by the assumed results of the recommendations will constitute the “Best Practise Scenarios”.

Summary of Best Practise Actions and Scenarios

Action	5-year impact	20-year impact
Establish a plan for staffing and training needs in connection with NT2 and other projects in the area.	Resettlement and livelihood restoration and development appropriately carried out.	Maintenance of adequate livelihoods in the resettlement villages.
Provide training and equip STEA and SEMD with resources needed for monitoring and follow up of NT2 and other projects.	Better quality assurance of the NT2 resettlement social development and resettlement process.	Environmental assessment and safeguarding established as a procedure in connection with development projects
Strengthen the role of the government as regulator through capacity building and establishment of a development framework.	A more balanced development process and a clearer role for the private sector in development process.	Better government control of the development process.
Strengthen integrated planning institutions at all levels of government through focusing on environmental assessment, capacity building and clarification of roles.	A more balanced development taking into consideration overall development goals and more efficient resource allocation between sectors.	A more effective and sustainable use of available natural and financial resources.
Establish programmes to increase the competence and capacity of the administrative staff for nature conservation.	Gradually improve the control of activities in the NBCAs.	Will lessen the pressure otherwise induced by the focus on Nakai –Nam Theun NBCA.
Develop a comprehensive and balanced plan for the establishment of new protected areas and NBCAs	Improved institutionalization of conservation efforts.	Might substantially improve the protection of NBCAs. Will allow for a more efficient use of resources for protection of biodiversity.

Explore the possibilities for setting up a fund for NBCA management with contribution from larger development projects (e.g. hydropower development).	Improved protection of NBCA surrounding the Nakai-Nam Theun NBCA .	More resources for management of NBCAs countrywide.
Develop EIA regulations and Environmental and Social Units / Divisions in all relevant ministries.	Secure that impact assessments are made for all project categories.	Give a better control of development activities and provide for balanced assessment of development projects.
Carry out an EIA for the Mahaxai cement factory.	Better overview of cumulative effects and a better basis for planning of mitigation activities.	Less long terms and lingering environmental and social effects.
Develop Strategic Impact Assessments for the most important and relevant sectors.	Improved basis for planning and prioritization of development projects.	A more balanced development with less negative environmental and social ramifications.
Increase the EIA competence and capacity in all sectors both in Central administration and in the Provinces.	More professional handling and control of the EIA processes.	Efficient implementation of mitigation and compensation measures related to development projects.
Establish bilateral legal arrangements between Lao PDR and Vietnam for planning, management and control of Nature Protection Areas.	Provide the basis for better control and protection of Nature Protection Areas.	Significantly improved control of illegal practises and trade in timber and wildlife.
Develop joint principles and plans for management and protection of border biodiversity areas.	Will provide a basis for better management.	Established systems of sustainable use of the most valuable biodiversity areas in the country.
Integrate China and Myanmar more into the MRC and GMS cooperation and initiatives.	Better information exchange.	Might have an influence on the development of Chinese hydropower project, size, sequence, operation etc. and consequently on the downstream impacts.
Strengthen the legal mechanisms for implementation of the Mekong Agreement.	Will facilitate implementation of the principles for fair and equitable use of water resources and contribute to conflict resolution between countries.	Will improve the processes of consultation regarding downstream impacts of projects. Might lead to modification of project plans and reduce water related negative impacts.
Give MRC a leading role in water related Cumulative Impact Assessments and Strategic Impact Assessments.	Better upfront awareness of environmental and social impacts related to sector developments in the Mekong Basin.	A more balanced development of water related sectors and less negative environmental and social impacts.

TABLE OF CONTENTS

1	BACKGROUND AND PROGRESS	1
1.1	The Nam Theun 2 Hydropower Project	1
1.2	Emerging Requirements for Cumulative Impact Assessment	1
1.3	Relations to Project Specific Impact Studies	1
1.4	Regional Relevance	2
2	ANALYTIC PROCESS	4
2.1	Scope of Work in the Terms of Reference	4
2.1.1	Thematic Coverage	4
2.1.2	Preparation of Development Scenarios	4
2.1.3	Institutional Issues and Capacity Building	5
2.1.4	Outputs	5
2.2	Results of Initial Consultation and Inception Report Workshop	6
2.3	Team Composition	6
3	ADMINISTRATIVE AND LEGAL FRAMEWORK	7
3.1	Introduction	7
3.2	National Legal and Institutional Situation	7
3.2.1	Environment Protection	7
3.2.2	Forestry	7
3.2.3	Water Management	7
3.2.4	Resettlement Policy and Regulation	8
3.2.5	Land Ownership and Land Use Rights	8
3.3	International Commitments	8
3.3.1	Mekong River Commission	8
3.3.2	ASEAN Membership	9
3.3.3	Greater Mekong Sub-region (GMS) initiative	9
3.3.4	International Conventions and Treaties	9
3.4	Impact Assessment Requirements and Safeguard Principles	9
3.4.1	EIA process	9
3.4.2	The Banks' Project Preparation and Consultation Process	11
4	NAM THEUN 2 HYDROPOWER PROJECT AND ITS PREDICTED IMPACTS	12
4.1	Introduction	12
4.2	Technical features	12
4.2.1	The Reservoir	12
4.2.2	Power Plant and Water Diversion	12
4.2.3	Hydrology and Planned Operations	14
4.2.4	Associated Infrastructure	14
4.2.5	Regional and Cumulative Impacts and Implications	17
5	ASSUMED SECTOR DEVELOPMENTS	19
5.1	Introduction	19
5.2	Hydropower	19
5.2.1	Introduction	19
5.2.2	Mekong Perspective	21
5.2.3	Summary of 5-years and 20-years Power Development Plans	24
5.2.4	Local Perspective	25
5.3	Transport	25
5.3.1	Introduction	25
5.3.2	Regional Perspective	25
5.3.3	Local Perspective	25

5.4	Irrigation	28
5.4.1	Introduction	28
5.4.2	Regional Perspective	29
5.4.3	Local Perspective.....	30
5.5	Water Supply and Sanitation.....	32
5.5.1	Introduction	32
5.5.2	Mekong Perspective.....	32
5.5.3	Local Perspective.....	33
5.6	Urban Development	33
5.6.1	Introduction	33
5.6.2	Local Perspective.....	34
5.7	Fisheries.....	36
5.7.1	Introduction	36
5.7.2	Mekong Perspective.....	36
5.7.3	Local Perspective.....	37
5.8	Forestry	38
5.8.1	Introduction	38
5.8.2	Mekong Perspective.....	38
5.8.3	Local Perspective.....	41
5.9	Industry.....	42
5.9.1	Introduction	42
5.9.2	Local Level Developments	42
5.10	Mining.....	43
5.10.1	Introduction	43
5.10.2	Local Perspective.....	43
5.11	Social Development	44
5.11.1	Introduction	44
5.11.2	National Perspective	44
5.11.3	Local Perspective.....	44
5.12	Conservation	51
5.12.1	Introduction	51
5.12.2	National and International Perspective.....	51
5.12.3	Local Perspective.....	52
5.13	Development in Neighbour Districts of Vietnam and Thailand	54
5.13.1	Vietnam.....	54
5.13.2	Thailand	57
6	IMPACT ZONES	58
6.1	Introduction.....	58
6.2	Nakai Plateau	58
6.3	Nakai Nam Theun NBCA	58
6.4	Xe Bangfai Basin and Surrounding Districts	58
6.5	Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts.....	58
6.6	The Mekong Basin	60
7	PREDICTIONS OF CUMULATIVE IMPACTS.....	61
7.1	Introduction.....	61
7.1.1	Perspectives	61
7.1.2	Prediction of Trends, Impacts and Scenarios.....	61
7.1.3	Responsibility.....	61
7.2	Nakai Plateau	61
7.2.1	Introduction	61
7.2.2	Impact Predictions.....	62
7.2.3	Summary of Impacts	68
7.3	Nakai-Nam Theun NBCA	68
7.3.1	Introduction	68
7.3.2	Impact Predictions.....	68
7.3.3	Summary of Impacts	72

7.4	Xe Bangfai Basin and Surrounding Districts	72
7.4.1	Introduction	72
7.4.2	Impact Predictions.....	73
7.4.3	Summary of Impacts	82
7.5	Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts.....	82
7.5.1	Introduction	82
7.5.2	Impact Predictions.....	83
7.5.3	Summary of Impacts	91
7.6	Mekong River Basin	92
7.6.1	Introduction	92
7.6.2	Impact Predictions.....	92
7.6.3	Summary of Impacts	107
8	RECOMMENDATIONS FOR MANAGEMENT INTERVENTIONS	109
8.1	Introduction.....	109
8.2	Challenges and Recommendations	109
8.2.1	Implementation Capacity and Competence.....	109
8.2.2	Integrated Planning	111
8.2.3	Management of other NBCAs	113
8.2.4	Environmental Assessment.....	114
8.2.5	Cross-border Cooperation.....	115
8.2.6	Mekong Basin Planning	116
8.3	Best Practice Scenario	117
8.3.1	Introduction	117
8.3.2	“Best Practise Scenario”	117
9	REFERENCES/BIBLIOGRAPHY	120

Appendices

TOR

Consultation Process

Annexes (in separate volume)

1. **Sector Plans and Development Trends**, by Erik Børset and Jens Laugen
2. **Hydrology**, by Jean Pierre Bramslev
3. **Future Hydropower Development**, by Anders Korvald
4. **Fish Biodiversity and Fisheries**, by Terry John Warren
5. **Irrigation**, by Garry Oughten
6. **Health**, by Stanley H. Zankel
7. **Drugs and Human Trafficking**, by Jens Laugen
8. **Ethnic Minorities**, by Stephen Sparkes

LIST OF TABLES

Table 1: NT2 Reservoir Features	12
Table 2: Summary of Identified Project Impacts and their Mitigation	16
Table 3: Existing and Planned Projects in Yunnan	21
Table 4: EdL Generation Expansion Plan (2004-2020) for Domestic Projects and the most promising Export Projects (PSDP)	22
Table 5: Existing Projects in Thailand within Mekong Basin (EGAT 2004)	23
Table 6: Existing and Planned Projects in Vietnam within Mekong Basin. (Hydropower Master Plan 2004)	23
Table 7: Planned Projects in Cambodia within Mekong Basin.....	24
Table 8: Existing and Predicted Active Storage Volume (mill m ³) in the Mekong Basin.....	24
Table 9: Irrigated Dry Season Rice the LMB and Predicted Increase (km ²).....	29
Table 10: Existing Irrigated Land Potential Increase in the NT2 affected Basins	31
Table 11: ADP Planned Irrigation Schemes in Khammoauane	32
Table 12: Population Increase and Water Consumption	33
Table 13: Urban and Rural Population in NT2 Influence Area	34
Table 14: Estimated Population Increase in NT2 affected Urban Areas	36
Table 15: Fish Yield in Lower Mekong Basin (MRCS 2000).....	37
Table 16: Forest Cover in the Mekong Basin (MRC 1997)	38
Table 17: National Level and NT2 Area Health Data	44
Table 18: Existing Health Infrastructure in Khammouane Province.....	46
Table 19: Education Indicators for Khammouane Province 1998.....	47
Table 20: Poverty Incidence by Provinces Surrounding NT2	47
Table 21: Poor Districts in Provinces Surrounding NT2.....	49
Table 22: Ethnic Minorities in the Three Affected Provinces	50
Table 23: Main Ethnic Groups in Project Area and Surrounding Areas.....	51
Table 24: Summary of the most Important Cumulative Impacts on the Nakai Plateau	68
Table 25: Summary of the most Important Cumulative Impacts in Nakai-Nam Theun NBCA.....	72
Table 26: Summary of the most Important Cumulative Impacts in Xe Bangfai Basin	82
Table 27: Population and Migration along Route 8 (1995-2003)	90
Table 28: Summary of the most Important Cumulative Impacts in Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding District	91
Table 29: Summary of Cumulative Impacts on Mekong flow at Selected Locations	99
Table 30: Summary of the most Important Cumulative Impacts in Mekong River Basin.....	108
Table 31: Estimated Staff Needs of NT2 in Relation to Available District Staff	110
Table 32: Staffing and Qualification Level of Provincial and Central Agencies	110
Table 33: Summary of Best Practise Actions and Scenarios.....	117

LIST OF FIGURES

Figure 1: Annual Variation in Monthly Mean Flow in Xe Bangfai Pre- and Post-NT2 (two options for NT2 power production).....	74
Figure 2: Cumulative Impact of Discharge into Theun-Hinboun Headpond.....	83
Figure 3: Reduction of Flow at Pakkading (downstream Theun-Hinboun dam).	84
Figure 4: Changes in Flow in Nam Hinboun.....	85
Figure 5: NT2 Impact on Mekong Discharges at Savannakhet.....	93
Figure 6: Summary of NT2 Impacts on the Mekong, as relative flow changes.....	94
Figure 7: Summary of Cumulative Impacts on the Mekong, as relative flow changes.....	97
Figure 8: Cumulative Impacts 2025 on Mekong Monthly Flow at Savannakhet.	97
Figure 9: Cumulative Impacts 2025 on flow in Tonle Sap. Positive Flow is from the Lake to Mekong, Negative Flow is from Mekong to the Lake.	98
Figure 10: Cumulative Impacts 2025 on Great Lake Inundated Area.	99

LIST OF MAPS

Map 1: Location of Nam Theun 2 within the Mekong River Basin.....	3
Map 2: Principal Project Features.....	13
Map 3: Existing and Planned Hydropower Projects in the Mekong River Basin.....	20
Map 4: Infrastructure and Industry.....	27
Map 5: Land Use and Forest Cover in the Mekong River Basin.....	39
Map 6: Forest Resources.....	40
Map 7: Conservation Areas.....	53
Map 8: Impact Zones.....	59
Map 9: Cumulative Impacts on Hydrology 2025.....	101
Map 10: Population Density in the Mekong River Basin.....	106
Map 11: Major Irrigated Areas.....	107

LIST OF ABBREVIATIONS/ACRONYMS

ADB	Asian Development Bank
ADF	Agence de Développement Française
ARI	Acute respiratory illnesses
BDP	Basin Development Plan
CIA	Cumulative Impact Assessment
DCTPC	Provincial Departments of Communication, Transport, Post and Construction
DRWG	District Resettlement Working Group
EAMP	Environmental Assessment & Management Plan
EIA	Environmental Impact Assessment
EdL	Electricité du Lao
EGAT	Electricity Generating Authority of Thailand
EM	Ethnic Minorities
EMDP	Ethnic Minorities Development Plan
EMP.	Environmental Management Plan
EMU	Environmental Management Unit
FAO	UN Food and Agriculture Organisation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographical Information System
GoL	Government of Lao
IPP	Independent Power Project
IUCN	International Union for Conservation of Nature
LMB	Lower Mekong Basin
MCTPC	The Ministry of Communication, Transport, Post and Construction
MOU	Memorandum of Understanding
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
MW	Megawatt
NBCA	National Biodiversity Conservation Area
NGO	Non Governmental organisation
NT2	Nam Theun 2
NT2-HP	Nam Theun 2 Hydropower Project
NTFP	Non-Timber-Forest-Product
NTPC	Nam Theun 2 Power Company
OCR	Optical Character Recognition
PDP	Power Development Programme
PDR	People's Democratic Republic
PPA	Participatory Poverty Assessment
PSDP	Power System Development Plan
RAP	Resettlement Action Plan
RMU	Resettlement Management Unit
SCME	State Coal Mining Enterprise
SEMFOF	Social and Environment Management Framework and Operation Plan
SIA	Sectoral / Strategic Impact Assessment
SIDA	Swedish Development Agency
SMEC	Snowy Mountain Engineering Company
STEA	Science, Technology and Environment Agency
STI	Sexually Transmitted Infection
SUFORD	Sustainable Forestry for Rural Development Project
TA	Technical Assistance Projects (ADB)
THB	Theun Hinboun
ToR	Terms of References
UN	United Nations

WB	World Bank
WBG	World Bank Group
WCS	Wildlife Conservation Society
WMPA	Watershed Management and Protection Authority
WUP	Water Utilisation Plan
WWF	World Wide Fund for Nature

ACKNOWLEDGEMENTS

The association of NORPLAN A/S and EcoLao has prepared this report for the Government of Lao PDR under the technical assistance provided by ADB and with technical input from the World Bank.

Without the active contribution and guidance from these organisations the preparation of this report would have been impossible. A special thank is due to the Ministry of Industry and Handicraft, Department of Electricity, which hosted the study and provided office space and support as well as good working ambience.

In addition we would like to thank all the other persons and parties, which have provided information and input to the study. In particular we are indebted to NTPC and MRC secretariat for their support, sharing of knowledge, and generous provision of data, maps, thematic reports etc.

1 BACKGROUND AND PROGRESS

1.1 The Nam Theun 2 Hydropower Project

The Nam Theun 2 (NT2) Hydropower Project is the largest infrastructure development project in the Lao People's Democratic Republic (Lao PDR). The project is being developed and will be implemented through the co-operation of the government of Lao PDR and the Nam Theun 2 Power Company (NTPC). The Asian Development Bank (ADB), the World Bank Group (WBG) and Agence Française de Développement (AFD) are considering the project for financial support.

1.2 Emerging Requirements for Cumulative Impact Assessment

Environmental Impact Assessments are today more or less universally established as essential elements in the planning of large development projects. Most countries and international donors have their specific EIA requirements. However, in recent years certain shortcomings in project specific EIAs have been noted. These relate both to the combined impacts of development projects in a specific sector, as well as to the cumulative impacts of activities and plans in different sectors over a longer period of time. Specifically, for large-scale dam projects, the World Commission on Dams, in their report of November 2000, underlined the need for broader "upstream" assessments of the development alternatives and scenarios.

The international funding institutions have responded to this need for broadening the scope and coverage of environmental assessments by establishing Sectoral / Strategic Impact Assessments (SIAs) and Cumulative Impact Assessments (CIAs) as elements in their environmental and social safeguard procedures. The ADB environmental assessment requirements are presently under revision and the CIA requirements are expected to be included as an integral element of all future assessment procedures for major projects.

Examples of projects where CIAs have been carried out are, however, still few, and the approach and methodology is at a developmental phase. The present study can, therefore, be seen as contributing to this process in terms of CIA methodology and presentation format.

1.3 Relations to Project Specific Impact Studies

A traditional EIA is a project specific EIA. The major analytic element of the assessment is the prediction of potential impacts by introducing a specific, new development initiative in a well-defined natural and social environment. The baseline conditions, on which the predictions are made, are the conditions at the time of study preparation. Only to a limited extent are the project impacts of future options and possible developments included in the analysis. The geographic coverage of the study is also normally limited to the directly impacted area.

Whereas EIAs concentrate on the impacts of one specific project, the CIA tries to analyse the combined impacts of a series of projects, future developments and plans, either implemented together or in a sequence. The present cumulative assessment will concentrate on assessing the impacts of the proposed NT2 Project in the light of other existing or planned developments. The definition of the

potential impact area will normally extend far beyond the impact area of a project specific EIA study.

In the case of the NT2 hydropower project cumulative impacts can be seen as:

Effects other (future) developments in the area have on the type and magnitude of the NT2 impacts. (Added impacts).

Impacts of development in other sectors that are induced by NT2 activities and its supplementary components. (Induced impacts).

These are the cumulative impacts in a strict sense. In addition regional and transboundary impacts are often included. Such impacts are not necessarily “cumulative” but are included because the impacted area is outside what is normally the area of focus for a project specific study.

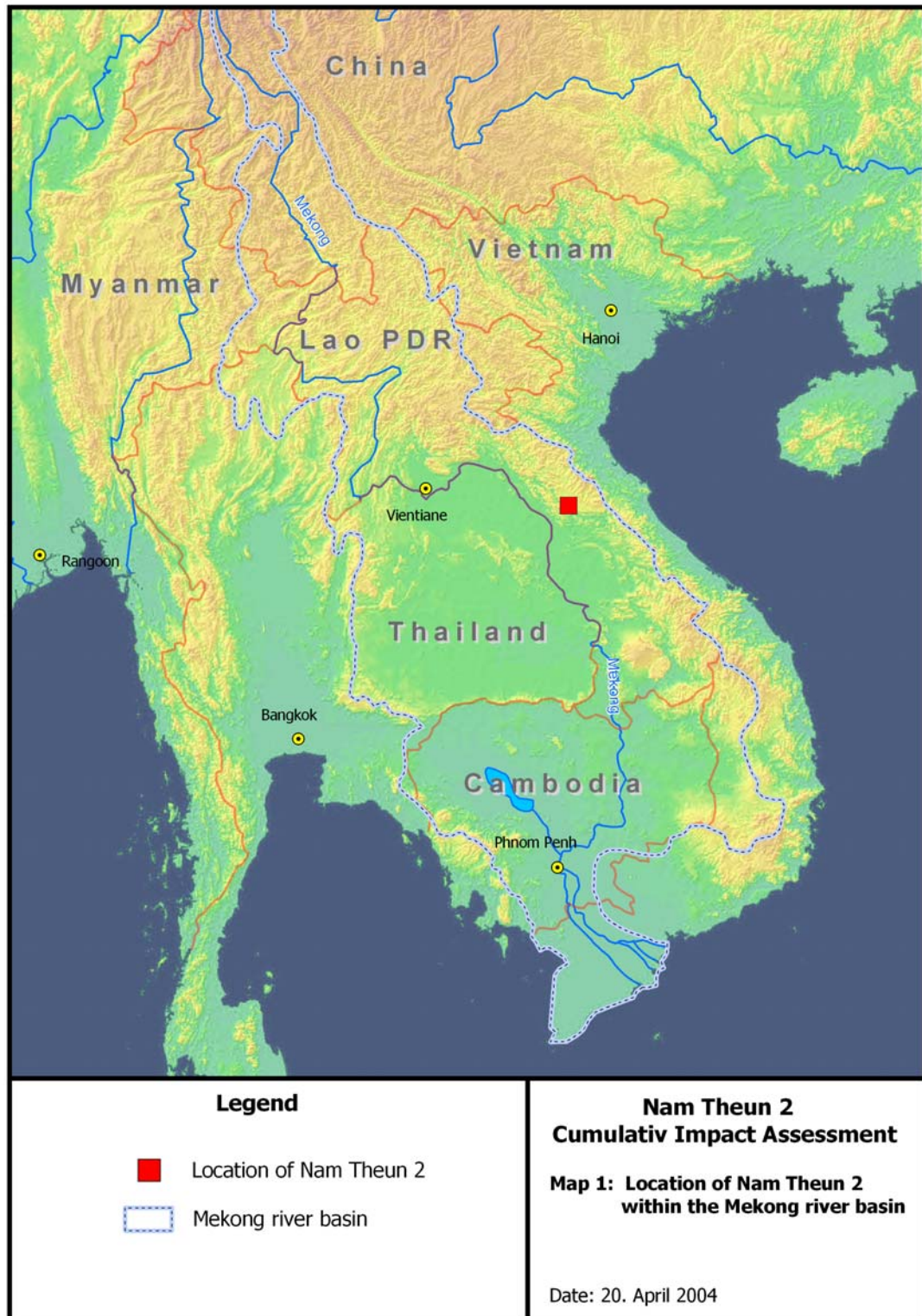
Thus the CIA perspective is beyond what is normally required to be covered in a “project specific EIA”, which has to be produced by the project developer as part of the project approval process.

1.4 Regional Relevance

The Cumulative Impact Assessment and integrated development planning are particularly important for water related projects since the river and its drainage basin should be seen as an interlinked planning unit (the concept of Integrated Water Resources Management). This is even more so when the basin is large and covers several countries, as the Mekong Basin.

The need for a basin-wide approach is recognised by the Mekong River Commission (MRC), which has taken important initiatives to initiate and create the tools for integrated water resources planning and assessment of large water related projects in the region. In particular two on-going programmes are focusing on these matters: the Water Utilisation Plan (WUP) and the Basin Development Plan (BDP). These two programmes have provided a number of valuable thematic studies for this report. The programmes have, however, not yet reached a level whereby new planning models or analytical tools are available for use in a concrete case such as in this NT2 CIA.

In the regional Mekong perspective there are questions raised about NT2 Project plans and its potential downstream impacts. These relate in particular to the downstream impacts on hydrology, fisheries, agriculture and transport. The background material for analysing such regional cumulative impacts will primarily be based on MRC documentation and data.



2 ANALYTIC PROCESS

2.1 Scope of Work in the Terms of Reference

2.1.1 *Thematic Coverage*

The issues to be covered in the CIA are based on the outcome of earlier studies and from questions raised in the project preparation process. A number of direct and indirect impacts have been identified as a potential result of the combination of the NT2 project and other medium and long-term developments. The following areas of concern are mentioned in the ToR:

- Hydrology
- Vulnerability to flooding
- Social issues
- Fisheries
- Water quality
- Transport
- Water supply and irrigation
- Urban development
- Institutional issues
- Biodiversity

According to the ToR the primary geographic areas to be covered in the study are:

- Mekong River Basin
- Nam Kading and Xe Bangfai River Basins
- The linear development zone associated with the transmission lines

Also the receiving basin for the Theun Hinboun Project – Nam Hinboun will be covered in this report.

The problems and issues will differ with the geographic area and time perspective. The CIA aims to be flexible and realistic in determining the level of detail for the assessment and geographic focus required to cover important issues. For certain development issues administrative units, such as districts and provinces or border areas between states will be more relevant than the river basin perspective.

In reporting the cumulative impacts a structure of four different geographic zones has been chosen for summarising the impacts. The definition and a brief description of these four impact zones is given in Chapter 6.

2.1.2 *Preparation of Development Scenarios*

The analytic baseline for the impact assessment is a set of plans and development trends in the following sectors:

- Hydropower

- Transport
- Irrigation
- Water Supply and Sanitation
- Urban Development
- Fisheries
- Forestry
- Industry
- Mining
- Social Development
- Conservation

The relevant development plans and trends for the above-mentioned sectors are summarised in Chapter 5. A more detailed documentation of the present situation, plans and development trends can be found in Annex 1.

In Chapter 7 an assessment is provided for the cumulative impacts in the short term (five-year planning horizon) and in the long term (twenty year planning horizon). It has been decided to define the short-term horizon to be the year of commissioning of NT2, i.e. **2010**, and the long-term horizon to be 15 years later, i.e. **2025**.

The combined impacts caused by all the analysed sectors, together with the potential impacts of NT2 is then summarised in an **overall five-year scenario** and an **overall 20-year scenario**. These first analytic scenarios will represent the **business as usual** development pattern.

Chapter 8 presents recommendations on actions and interventions to modify or avoid the potential negative impacts identified in Chapter 7. The final section of this chapter presents a summary of the assumed impacts provided that the proposed recommendations and conditions are implemented. This assessment constitutes the second set of scenarios, which reflects the **best practise** with broad policy support for environmentally and socially sensitive development.

2.1.3 *Institutional Issues and Capacity Building*

Institutional, management and capacity building issues affect all sectors of this study. Although there are specific issues related to management, training and capacity for the different sectors, there are a number of common concerns and challenges. Hence, these issues will be touched upon when analysing the scenarios but a fuller treatment will be provided in Chapter 8.

2.1.4 *Outputs*

The anticipated major outputs of the study are:

- A comprehensive understanding of the cumulative impacts of the Nam Theun 2 Hydropower Project in a regional context, both in the project area and in the downstream riparian countries along the Mekong River and adjacent project areas.
- Recommendations to relevant stakeholders to better address the identified cumulative impacts and improve their planning programmes.

- A test of a possible methodology and presentation format for Cumulative Impact Assessments. This might be useful in the process of introducing the CIA as a standard requirement for larger ADB infrastructure projects.

2.2 Results of Initial Consultation and Inception Report Workshop

In meetings with the client and key stakeholders the focus and priorities of the study have been discussed. It was recognised that the time and the budget available for this study did not allow for collection of primary data. The method of work would basically be desk studies. Even with this approach the study has to be focussed on the issues that are most important for the consultation and decision-making processes for the NT2 Project. This means that not all sectors and issues are necessarily handled with the same level of detail and geographic coverage.

The Inception Workshop, which attracted broad participation from different government agencies and stakeholders including NGOs, gave further direction and recommendations as to the focus and the issues.

2.3 Team Composition

The Norwegian consulting company NORPLAN A/S in association with the locally based consulting company EcoLao has prepared the CIA study.

The study team consisted of:

Erik Børset, Team Leader and Terrestrial Ecologist

Jean Pierre Bramslev, Hydrologist

Terry John Warren, Fisheries and Aquatic Ecology Specialist

Stanley H. Zankel, Health Specialist

Stephen Sparkes, Indigenous Peoples and Social Sector Specialist

Garry Oughon, Irrigation / Agriculture Specialist

Kjetil Mork, GIS and Biodiversity Specialist

Jens Laugen, Development Planning Specialist

Anders Korvald, Hydropower Specialist

3 ADMINISTRATIVE AND LEGAL FRAMEWORK

3.1 Introduction

The national legal framework and requirements and the relevant administrative structures are all described in detail in the different project specific studies for the NT2 Project. Other studies, which focus on the institutional capacity for implementation of regulations and plans are presently under preparation.

In the following a brief summary of the administrative and legal situation in the main relevant national sectors, Lao PDR international commitments, and the environmental and social requirements of the International Financing Institutions is provided.

3.2 National Legal and Institutional Situation

3.2.1 Environment Protection

The basic legal framework is laid down in the Environmental Protection Law of 1999, which was approved by the implementation decree of 2002. The law includes provisions for EIA for projects and activities that might have an impact on the environment, and regulations for all enterprises to control pollution and comply with environmental quality standards.

The executing agency is the Science, Technology and Environment Agency (STEA), which also is in charge of reviewing EIAs. STEA has developed specific guidelines for the content and process of environmental assessment of hydro-power projects, including the preparation of environmental management plans.

The conservation of areas for biodiversity purposes has its legal basis in the Prime Ministers (PM) Decree of 1993 aimed at fulfilling the Lao PDR obligations under the Convention of Biological Diversity. Through this decree 20 National Biodiversity Conservation Areas (NBCAs) have been established, including the Nakai-Nam Theun NBCA. The administrative responsibility for the management of the NBCAs has been placed at the Ministry of Agriculture and Forestry (MAF).

3.2.2 Forestry

The Forestry Law of 1996 gives the general provision for management of all forest related resources, including all plants, wildlife, watercourses, etc. The Department of Forestry, Ministry of Agriculture and Forestry, has the overall responsibility. GoL is responsible for allocating the use of forestland and forest resources. Forests are grouped into the following five categories: Protection, Conservation, Production, Regeneration, and Degraded, each with their specific management policy.

3.2.3 Water Management

The Law on Water and Water Resources of 1996 is intended to assure sustainable use of water. Water use is categorised into small, medium and large-scale use. The legislation prescribes the rights and permit procedures for the different categories of water use. Development of a large-scale user projects will require the preparation of an EIA. The administration of the Water Law is located in the Water Resources Coordination Committee under the Prime Ministers Office.

3.2.4 *Resettlement Policy and Regulation*

A Draft National Resettlement Policy was issued by GoL in 1997. The principles of this policy has been included in the Electricity Law, the Water Law and the Road Law, all of which now require developers to provide the affected people with compensation and/or replacement for lost land. A set of regulations for preparing and implementing involuntary relocation programmes has been issued.

The Nam Theun 2 Resettlement Committee issued a resettlement policy specific to the NT2 Project in 2002. The policy prescribes provision of agriculture and forestry land and developing compensation packages. The objective is to provide means for a sustainable livelihood for the affected population.

In addition to the draft resettlement policy and regulation, a Decree on Resettlement and Compensation was issued in June 2004. The Decree aims at:

- help integrating social dimensions and mitigation measures into development projects with special focus on vulnerable groups;
- ensuring that provisions for mitigation measures in other applicable laws, decrees and the national policy on resettlement and compensation are adhered to, and;
- ensuring that the project affected population share in the benefits of the development project and that their livelihoods and living standards are restored to at least pre-project level.

3.2.5 *Land Ownership and Land Use Rights*

Most of the agricultural land in Lao PDR is still held through traditional and customary rights but there are ongoing initiatives both in the form of the World Bank supported “Land Titling Project” and the “Land and Forest Allocation Program” of the Ministry of Agriculture and Forestry that is providing an increasing number of farmers with land titles and legal deeds to their land.

The legal basis for land use and land ownership is provided in the Land Law of 1996 and Land Decree No. 99. In principle the State owns all land but long term occupancy and utilization rights for individuals are recognised.

3.3 **International Commitments**

3.3.1 *Mekong River Commission*

Lao PDR is one of the four signatory parties to the 1995 Agreement on the Co-operation for Sustainable Development of the Mekong River Basin and one of the members of the Mekong River Commission (MRC). The Commission succeeded the Mekong Committee, which, among other things, was instrumental in the planning of Nam Ngum, the first larger hydropower project in Lao PDR. Whereas the Committee was primarily focussed on hydrology, navigation and hydropower, the mandate of the Commission is more oriented towards co-operation for the promotion of sustainable development, utilisation, management and conservation of the water and related resources of the Mekong River Basin.

The primary purpose of the Agreement is to promote economic and social well-being of the people in all the riparian countries through the protection of the environment, improvement of navigation and the cooperation in the maintenance of flows and intra-and inter-basins diversions. As mentioned in Chapter 1, MRC

has initiated several basin-wide planning and research programmes, including the Water Utilisation Plan (WUP), the Environmental Programme (EP), the Basin Development Plan (BDP) and the Fisheries Programme.

Lao PDR has its own National Mekong Secretariat in Vientiane.

3.3.2 *ASEAN Membership*

Lao PDR became a member of the Association of Southeast Asian Nations (ASEAN) in 1997. ASEAN countries have adopted an agreement on the Conservation of Nature and Natural Resources. However, this agreement has been ratified by only three countries since it was adopted in 1985, and is therefore not in force. ASEAN also has provisions to assist member countries to establish trans-boundary nature reserves.

3.3.3 *Greater Mekong Sub-region (GMS) initiative*

In 1992, with the assistance of ADB, Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, Viet Nam, and Yunnan Province in the People's Republic of China entered into a program of sub-regional economic cooperation, designed to enhance economic relations among the countries. The program has contributed to infrastructure development and better use of the resource base in the sub-region.

3.3.4 *International Conventions and Treaties*

Convention on Biological Diversity (CDB)

Lao PDR became a signatory to the CDB in 1992, following up the ASEAN Agreement of the Conservation of Nature and Natural Resources, which was signed in 1985. The obligations of CDB have been fulfilled in terms of new policy and legislation and by establishing NBCAs.

Convention on the protection of World Cultural and Natural Heritage

This convention was ratified by GoL in 1987. The convention addresses the protection of both cultural and natural objects and sites of high national and international value.

Convention on International Trade in Endangered species (CITES)

Lao PDR ratified this convention in early 2004. Prior to the ratification, the Ministry of Agriculture and Forestry (MAF) issued a regulation that banned all hunting for trade. Hunting for consumption was still allowed. This is a signal that GoL is now committed to increasing efforts to halt the extensive trade in wildlife from Lao PDR to its neighbouring countries.

3.4 **Impact Assessment Requirements and Safeguard Principles**

3.4.1 *EIA process*

The process of Environmental Impact Assessment is a method used by the Asian Development Bank (ADB) and the World Bank (WB) to ascertain the environmental risks and benefits associated with their lending operations and other financial support to development projects. The Environmental Policy of the ADB dates from November 2002 and forms the basis for environmental requirements and interventions for project implementation. The Environmental Assessment

Guidelines (2003) describe procedures and methodology to be used to investigate environmental and social impacts of projects to be considered for funding. The WB's environmental assessment procedures are described in OP/BP 4.01 (Operational Policy, Bank Procedures). This policy is considered to be the umbrella policy for the Bank's "safeguard policies", which includes specific requirements and policies

In both ADB and WB projects Environmental Assessment (EA) plays a key role in improving decision-making and in ensuring that project options under consideration are sound and sustainable.

Involuntary Resettlement

The ADB policy on involuntary resettlement (1995) outlines the main issues of relocation, compensation and rehabilitation, drawing on the experiences of many donors in implementing and evaluating resettlement programmes. The policy emphasises avoidance of resettlement wherever feasible and minimisation of resettlement when it is unavoidable. It prescribes that all losses of assets, livelihood and income should be compensated for in full, specifying that an absence of formal legal title to land and access to resources should not be a bar to full compensation.

The World Bank's OP/BP 4.12 (2002) is based on the principle of informed participation of the affected people in resettlement planning and implementation. The policy is to ensure that people affected by a project have their standard of living improved, or at least maintained on the same level. Resettlement should be carried out in a manner that is consistent with cultural preferences. The policy requires that thorough baseline studies be conducted to identify affected people and the extent of impacts. A full resettlement action plan is required in those cases where more than 200 people will be displaced. In cases where less than 200 people are displaced, an abbreviated resettlement plan may suffice.

Indigenous People/Ethnic Minorities

The ADB's Policy on Indigenous Peoples (1998) aims to ensure that indigenous peoples, in the context of Lao PDR called 'ethnic minorities', have opportunities to participate in and benefit equally from development. It draws up strategies and approaches that are designed to avoid negatively affecting ethnic minorities in its operations, and to provide adequate and appropriate compensation when a negative impact is unavoidable. Open and transparent consultations are an integral part of this process.

In the World Bank's OD 4.20 on Indigenous People (1997) transparent and meaningful consultations with directly affect ethnic minorities is required to be undertaken prior to the initiation of detailed project preparation. If ethnic minorities are considered vulnerable groups and are likely to be adversely affected by a project, the borrower is required to prepare Indigenous Peoples/Ethnic Minority Development Plans to mitigate adverse impacts and to promote tailoring of benefits based on the preferences of the people concerned.

Safety of Dams (OP/BP 4.37)

For large dams (15 meters or more) it is a requirement that the borrower adopts and implements certain dam safety measures for the design, bid tendering, construction, operation and maintenance of the dam and associated works.

International Waterways (OP/BP 7.50)

The policy does not allow financing of a project on an international waterway until all the riparian countries are notified of the project. If there is an objection from one of the riparians, the Bank will assess and confirm that the project will not cause appreciable harm to the interests of the other riparians.

Cultural Property (OP 4.11)

The World Bank's general policy regarding cultural properties is to assist in their preservation, and to seek to avoid their elimination. The assessment of the value of cultural properties, possible impact and mitigation is covered by ADB's policy on resettlement and indigenous peoples.

Natural Habitats (OP/BP 4.04)

The World Bank does not support projects that, in the World Bank's opinion, involve the significant conversion or degradation of critical natural habitats.

3.4.2 *The Banks' Project Preparation and Consultation Process*

The ADB and WB are committed to ensure that key stakeholders are systematically identified and involved in project planning and implementation. Early consultations have to be held with affected groups to guide project decision making, and their views and preferences has to be reflected in the plans developed as an integral part of the project.

4 NAM THEUN 2 HYDROPOWER PROJECT AND ITS PREDICTED IMPACTS

4.1 Introduction

This chapter gives a brief summary of the basic features of the NT2 Project, the assumed project specific impacts, and the planned mitigation measures and preventive actions.

For more details about the Project development history, descriptions of the technical features of the project, and the project specific impacts and management plans, we refer to the Draft Environmental Assessment and Management Plan prepared by NTPC, October 2003. Map 2 shows the location of the project.

4.2 Technical features

4.2.1 *The Reservoir*

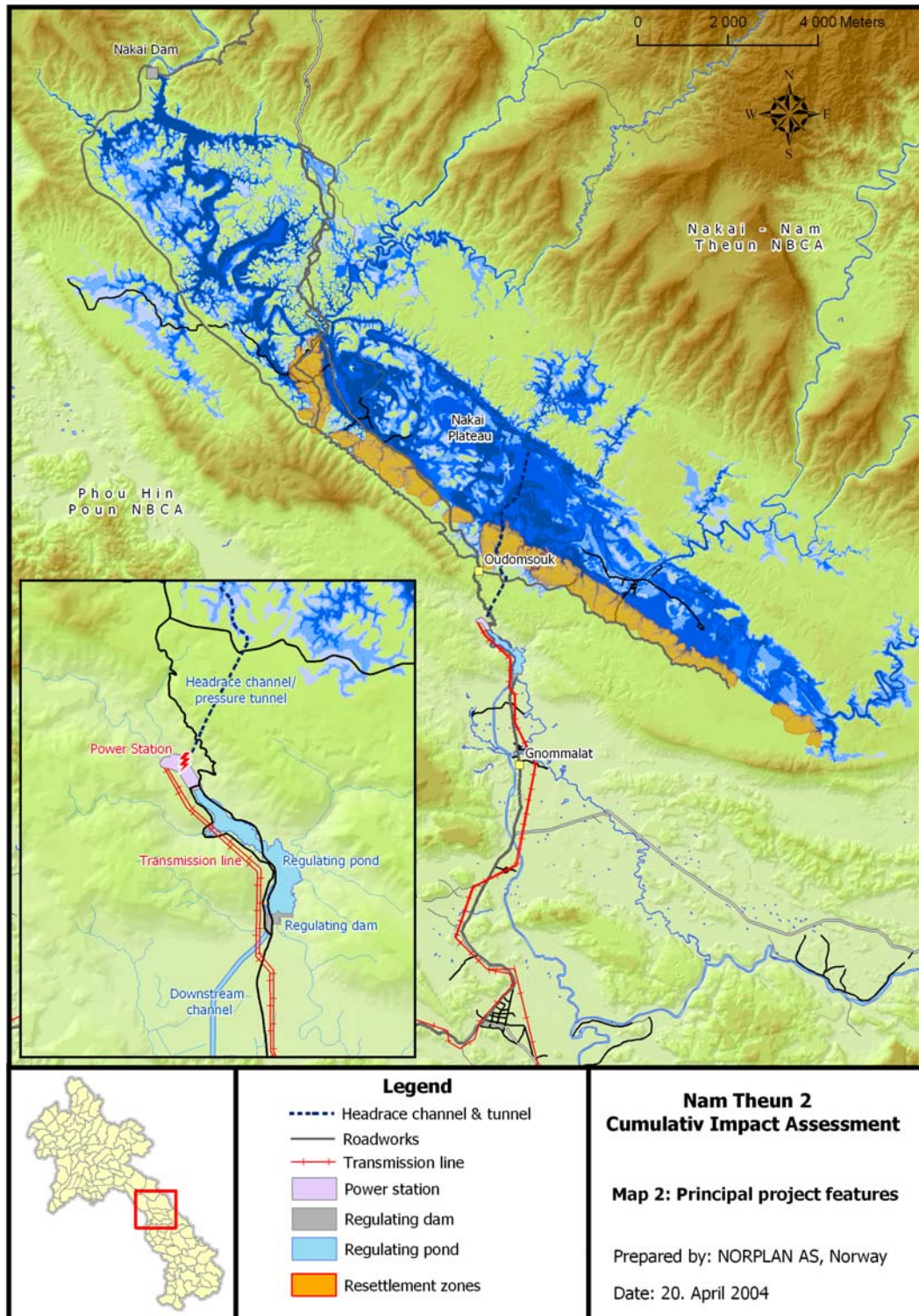
The Project reservoir will be formed by the construction of a 48 m high gravity dam with a crest length of 325 m across the Nam Theun, plus 13 small earthfill dams in saddles along the west bank of the reservoir. This will change the river and surrounding forestland into a lake that, at its highest level by the end of the wet season, will cover 450 km². In the dry season the surface area might be reduced to 82 km². The main features of reservoir are shown in Table1.

Table1: NT2 Reservoir Features.

Catchment Area	4,013 km ²
Total storage	3,900 million m ³
Live storage	3,530 million m ³
Full Supply Level (FSL)	El. 538.0 m
Minimum Operating Level (MOL)	El. 525.5 m
Surface Area at FSL	450 km ²
Surface Area at MOL	82 km ²

4.2.2 *Power Plant and Water Diversion*

The water in the reservoir will be diverted by a 3 km headrace tunnel, pressure shaft and pressure tunnel from the intake structure at Oudomsouk (Nakai) to the power station at the foot of the escarpment 10 km north of Gnommalath. This will create a gross head of 348 m. The power station will contain four Francis turbines for export production (EGAT) and two Pelton turbines for delivery to the local EdL distribution network. The total installed capacity will be 1074 MW.



The discharge from the power plant will be conveyed through a short tailrace channel into a regulating pond, which will allow for buffering of fluctuations in the water release created by daily peaking operations of the plant. From the regulating pond the water will be lead through a 27 km long channel discharging into Xe Bangfai upstream of Mahaxai. An aeration weir will be built to reduce the content of methane and hydrogen sulphide and to improve the oxygen concentration in the water. Several outtakes for irrigation purposes will be constructed along the channel.

4.2.3 *Hydrology and Planned Operations*

The catchment area of the reservoir is 4,013 km², most of it located in the Nakai-Nam Theun Biodiversity Conservation Area (NNT NBCA). Due to this relatively undisturbed catchment, the water quality is good with high transparency. The average annual runoff is 7,487 million m³. With live storage capacity of 3,530 million m³ the reservoir will easily be filled in the wet season. Based on the statistics available, the yearly water flow of the Nam Theun was greater than the reservoir's total capacity in 49 out of the 50 years since records began.

The environmental flow requirement (riparian release) in Nam Theun downstream of the dam site is set to 2 m³/s (approximately 5.2 million m³ per month) + 5 million m³/year to be used for flexible release. The unregulated flow is today about 20 m³/s in the dry season and 1500 m³/s in the wet season.

The main volume of water will be transferred from the reservoir through a tunnel to the power plant and discharged into the river basin of Xe Bangfai. The power plant will operate on a daily peaking mode. The discharged water from the power plant will increase the water flow in Xe Bangfai with an average of 250 m³/s. This will double the dry season flow and add about 10% to the natural wet season flow in Xe Bangfai.

4.2.4 *Associated Infrastructure*

Roads

A number of roads will be constructed or improved as part of the planned project:

- The existing roads 12 and 8B between Thakhek and Ban Gnommalath will be upgraded and bridges reinforced where necessary.
- Between Gnommalath and Ban Oudomsouk, on the Plateau, the existing road (8B) will need significant upgrading.
- A new road will be constructed to replace the sections of 8B that will be inundated by the planned reservoir.
- A new access road will be constructed to enable transport to the Nakai dam site at Nam Theun.
- In addition a number of existing smaller roads will be improved to enable access to the resettlement villages and farm plots on the plateau.

Camps and Residence

Four areas have been identified for construction work camps:

- Nakai Dam Area Construction Camp to accommodate about 800 workers,
- Oudomsouk Work Camp for intake structure and upper tunnel workers, with capacity for about 800 workers,

- Power Station Work Camp for lower tunnel, power station, regulating pond works, catering for about 2200 workers, and
- Downstream Work Camp for channel, quarry sites, etc. catering for about 400 workers.

In addition to the formal camp areas additional zones have been identified in the vicinity of camps that can accommodate businesses, families and other “followers” that normally will be attracted to the areas of new activity.

The project will establish an operator’s village close to the de-regulating pond area. This village will be the residence of about 150 permanent employees. This new village will have a post office, a telecom centre, shops, recreational facilities, a school, etc.

Resettlement Areas

The construction of the reservoir will require resettlement of about 5000 people in 21 villages and hamlets. The resettlement area is planned in about 208 km² in the forested land between the western shore of the reservoir and the escarpment. The Nakai District capital is also located in this area. The relocation distances vary between 5 and 0.5 km and the land is within familiar territory for most communities.

Transmission Lines

Adjacent to the power station a 500/115 kV substation and a 115/22 kV substation will be constructed. Electricity to EGAT will be delivered at the Thailand border north of Savannakhet via a 138 km long double circuit 500 kV transmission line. From the border a similar 160 km long line will connect to a new substation at Roi Et in Northeast Thailand. Energy to EdL will be transferred from the project substation via a 115 kV transmission line to a substation transformer in Thakhek. The detailed alignment of these transmission lines is yet to be decided.

Table 2: Summary of Identified Project Impacts and their Mitigation

Sectors	Direct and Indirect NT2 Impacts	Proposed Mitigation
Hydrology and water resources	<ul style="list-style-type: none"> ▪ Impoundment of 195 km of Nam Theun. ▪ Significant reduction in water flow in Nam Theun and Nam Kading. ▪ Significant increase in water flow in Xe Bangfai ▪ 3% reduction (in average) in water flow in Mekong from Nam Kading to Xe Bangfai. ▪ Reduced risk of flooding along Nam Theun and Mekong, increased risk along Xe Bangfai. 	<ul style="list-style-type: none"> ▪ Minimum bypass flow of 2 m³/s. below the Nakai dam. ▪ Construction of a regulating pond for a more constant release of water into Xe Bangfai. ▪ Restrictions on outflow from the reservoir in periods of floods in Xe Bangfai.
Water quality	<ul style="list-style-type: none"> ▪ Periodic episodes of low concentration of dissolved oxygen in parts of the reservoir (anoxic conditions) and downstream rivers. ▪ Increased nutrient concentrations during the initial years. ▪ Waste water discharges from construction sites and camps. 	<ul style="list-style-type: none"> ▪ Reduction of biomass in the inundation area (reservoir). ▪ Discharges into Nam Theun from the epilimnion of the reservoir. ▪ Construction of an degasification and aeration weir downstream of the regulating pond. ▪ Solid waste and wastewater management. ▪ Effective catchment management.
Erosion and sedimentation	<ul style="list-style-type: none"> ▪ Increased sedimentation in the inundation area (reservoir) and reduced sedimentation in Nam Theun downstream of the dam. ▪ Reduced riverbank erosion in Nam Theun downstream of the dam. ▪ Increased riverbank erosion in Xe Bangfai below the confluence with the downstream channel. ▪ Potential for erosion in downstream channel. 	<ul style="list-style-type: none"> ▪ Implement soil protection measures. ▪ Riverbank protection / stabilisation ▪ Lining of exposed sections of the channel. ▪ Asset and livelihood compensation.
Climate	<ul style="list-style-type: none"> ▪ Minor microclimatic changes (air temperature and relative humidity) around the reservoir. 	<ul style="list-style-type: none"> ▪ No mitigation measures.
Physical cultural resources	<ul style="list-style-type: none"> ▪ Several sites and physical structures of cultural significance are found within the inundation area. No sites on the Nakai Plateau have been classified as important with regards to historical and cultural values. 	<ul style="list-style-type: none"> ▪ Further studies of the affected sites on the Nakai Plateau will be conducted. ▪ Develop a management strategy / plan for sites and structures of archaeological, cultural or religious significance.
Terrestrial biodiversity	<ul style="list-style-type: none"> ▪ 1170 km² will be affected by the project (construction phase). Areas of mixed broadleaved and coniferous forests, swamps and gallery forests are most affected. ▪ 450 km² of forest, woodlands and other land will be lost in the inundation area. ▪ Habitats for a wide range of animals, including endangered/threatened species like Tiger, Elephant, Macaques, Dhole, Gaur, Banteng, White winged duck, etc. will be reduced. <p>Increased access to certain areas (NNT NBCA) and increased human population on the Nakai plateau will lead to increased hunting pressure and trade in wildlife.</p>	<ul style="list-style-type: none"> ▪ Designation of Nakai – Nam Theun NBCA. Management / protection funded by NTPC. ▪ Alternative livelihood systems combined with conservation for inhabitants of the NBCA ▪ Management plans for five species of mammals and ten species of birds. ▪ Conservation programmes for Asian elephant and White winged duck. ▪ Ban on hunting among workers.

<p>Aquatic habitats and fish diversity</p>	<ul style="list-style-type: none"> ▪ Transformation of a river (Nam Theun) into standing water (the reservoir) will disfavour species adapted to fast flowing conditions. ▪ The dam will represent a barrier for species migrating from lower Nam Theun to its headwaters. ▪ Large seasonal fluctuations in water level in the reservoir, and changes in water quality (anoxic conditions), are likely to lead to unfavourable conditions for some fish and other aquatic species. ▪ Changes in water flow and temperature in Xe Bangfai might alter the species composition and the productivity of the river. ▪ Work in or along rivers might increase the sediment load. This can cause damage to fish (gills), destroy spawning areas and reduce the productivity of the river. ▪ Potential for pollution from domestic wastewater and chemicals from workplaces and camps. 	<ul style="list-style-type: none"> ▪ Clearing of vegetation in the inundation area (reducing biomass). ▪ Diversion of the river away from the dam site during construction. ▪ Stabilisation of road sides and other affected areas in order to reduce erosion. ▪ Construction of retention tanks around areas where liquid and solid fuels and chemicals are stored.
<p>Social impacts</p>	<ul style="list-style-type: none"> ▪ Resettlement of approximately 5000 ethnic minorities on the Nakai Plateau. ▪ Potential in-migration that could lead to reduced capacity of local authorities and marginalisation of ethnic minorities. ▪ Influx of population could create inflation and shortages of essential goods due to increased demand. ▪ Increased competition for natural resources. ▪ Health impacts including the inability of existing services to cope with demand, increased STIs and the threat of the spread of HIV/AIDs, poor sanitation and spread of other communicable diseases. ▪ Direct impacts on downstream communities due to landtake for camps and project sites. ▪ Changes in water quality and water flow may result in the introduction or elimination of water-borne diseases. 	<ul style="list-style-type: none"> ▪ Livelihood packages for agricultural, fisheries and forestry development for resettlement communities. ▪ Improved institutional capacity for local, regional and national institutions for implementing resettlement and livelihood development plan. ▪ Exclusive rights for resettlers in relation to natural resource management. ▪ Health, education and community development initiatives for resettlers. ▪ Specific measures to ensure benefits for women. ▪ Culturally sensitive consultations and mitigation for ethnic minorities. ▪ Mitigation framework for monitoring and implementation of measures to enhance project benefits in the Xe Bangfai and other downstream areas (e.g. irrigation potential and capacity building). ▪ Support for local and regional capacity building for implementation of mitigation measures for GoL.

4.2.5 *Regional and Cumulative Impacts and Implications*

The reports listed in 4.3.1 briefly discuss some of the regional and cumulative aspects and potential impacts of the Project. Among others the following issues has been addressed:

- Changes in hydrology, water quality and flow along the Nam Theun/Nam Kading, the Xe Bangfai basins and to some extent the Greater Mekong River,

- Regional health development and health service in Bolikhamxai and Khammouane Provinces,
- Improved infrastructure, including upgrading of existing roads, new roads, electrification and water supply to resettler villages,
- Threats to the Nakai-Nam Theun NBCA caused by improved transportation and market access and population increase in the area surrounding the NBCA,
- Institutional capacity situation and the potential for improvements through training and management of the project at all government levels.

5 ASSUMED SECTOR DEVELOPMENTS

5.1 Introduction

The following presentation is an abstract of the key findings from the assessment of sector development trends and plans. A more detailed presentation of present status, plans and trends is given in Annex 1.

Efforts have been made to focus on the most relevant “driving forces” and projects that might have a synergetic effect on developments and impacts caused by the NT2 Project activities.

5.2 Hydropower

5.2.1 *Introduction*

The hydropower sector seems to be a thoroughly planned sector from an economic and the technical perspective. Over the last two decades, however, the definition of what is a feasible project and the principles of project ranking have changed substantially. Except for projects in Yunnan (China) and Sambor (Cambodia), it seems that none of the original plans for cascades of large power plants on mainstream Mekong are today considered realistic options.

The development in the 5-year perspective (2010) can easily be predicted. For most of the large projects to be implemented before 2010, the construction must have already started or the project must be in an advanced stage of project planning.

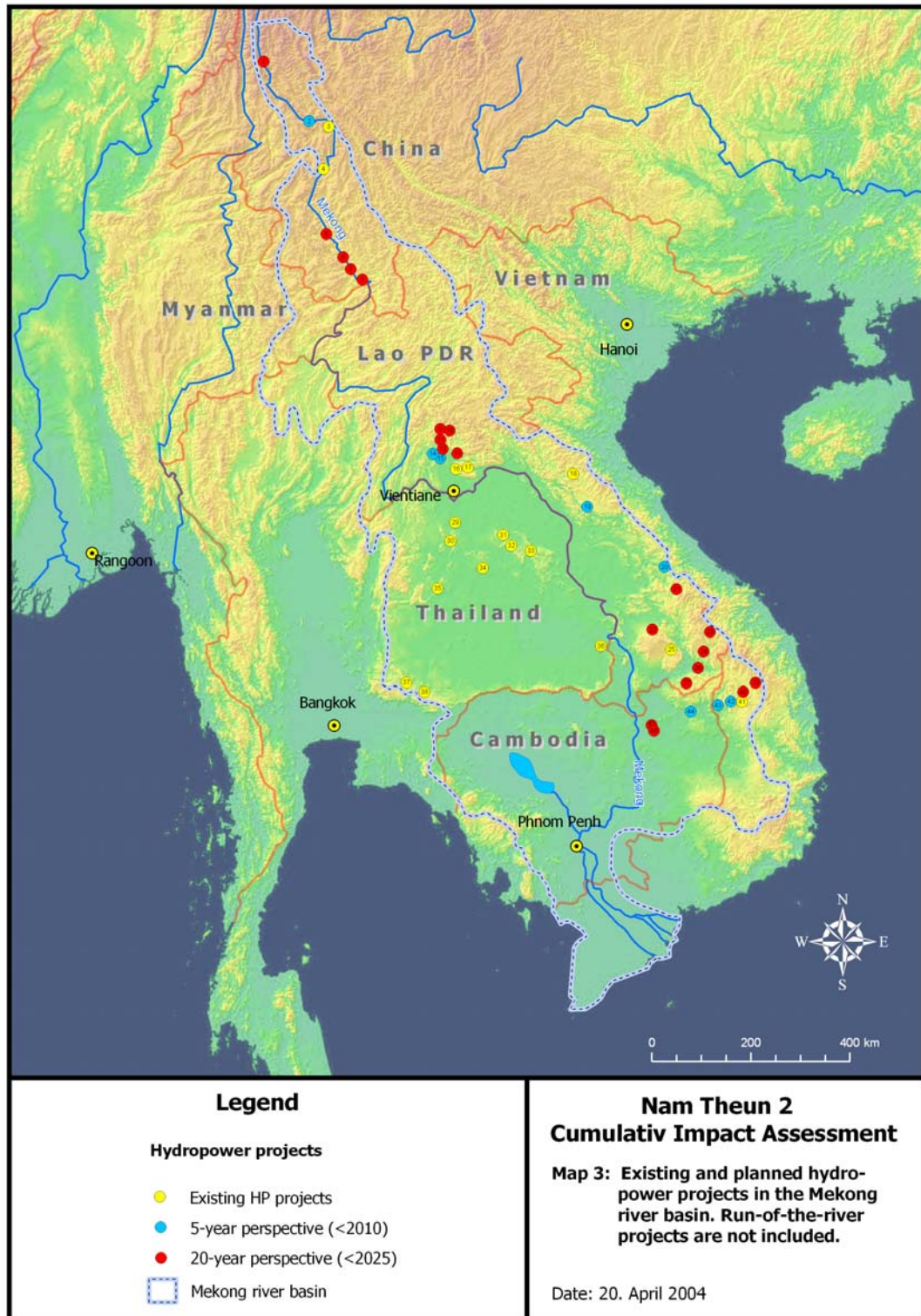
The 20-year (2025) situation is more difficult to determine with a reasonable level of precision. One problem is that the plans available to day have as a maximum a 2020 perspective. No official plans are available for the 2025 situation. If we consider, however, that as a general rule hydropower development plans tend to be over-optimistic, year 2020 perhaps represents an acceptable year for prediction of the CIA long-term scenario.

Even with elaborate development plans and strategies the final development and project sequence is uncertain. This is especially the case where development is largely dependent on trade agreements between the countries and on the participation of Independent Power Producers (IPP). The economic factors determining the price and the investment opportunities may change rapidly and thus influence the policy in the countries selling and buying energy.

The power development aimed at supporting national demand are easier to predict as this is more in the hands of the national electricity companies and is determined by long-term plans for electrification and estimates based on economic growth.

The hydropower developments are, in the CIA perspective, primarily relevant for changes in hydrology of the Mekong and on the Mekong tributaries influenced by NT2. The hydrologic impact on the Mekong is mainly caused by the reservoirs having the largest active storage, this being the main reason for an expected future change of water flow in the Mekong from wet season to dry season.

A large active storage has the potential of storing much water during wet season and supplying water during dry season. For hydropower plants a uniform water flow throughout the year results in the highest energy production.



Power plants with no, or only daily, storage are called Run of River (RoR) projects. They might be operated in a way that changes daily or weekly water flow downstream but are not capable of influencing the seasonal flow pattern downstream.

The flow characteristics generated by simulations of existing and planned hydropower projects serves as input to the water balance calculations reported in Chapter 7. Assumptions, technical data and energy simulation methodology is presented in more detail in Annex 3.

5.2.2 *Mekong Perspective*

Yunnan, China

In Yunnan in the Upper Mekong, two hydropower plants already exist on the mainstream of the Mekong. According to available information no new power plants will commence operation before 2010 in China. However, construction has started on one of the two largest reservoir projects, the Xiaowan HPP, with an expected date of commercial operation just after 2010. Hence, the project has been included in the analysis for 2010 together with the existing projects. In the period 2010 to 2025, five large new plants are assumed to start operation including the 5500 MW Nuozhadu HPP, see Table 3.

Table 3: Existing and Planned Projects in Yunnan

No. ¹	Project	Year of commissioning	Installed capacity (MW)	Active storage (mill. m ³)
3	Manwan	1993-96	1500	257
4	Dachaoshan	2001-2004	1350	367
2	Xiaowan	2010-14	4200	9900
1	Gonguoqiao	2012	750	120
6	Jinghong	2013	1500	249
5	Nuozhadu	2014	5500	12300
8	Mengsong	Before 2025	600	-
7	Ganlanba	Before 2025	150	-

¹ Numbers in this table corresponds to numbers in Map 3. No. 1 is upstream of No. 2 etc.

Lao PDR

In Lao PDR in the Power System Development Plan, PSDP (Meritec and Lahmeyer, 2004) has recently studied and prioritised a long list of about 30 projects including both project for domestic consumption and for export. In this CIA study the hydrological calculations are based on projects listed in the Electricité du Lao (EdL) Generation Expansion Plan 2005–2020 and the PSDP priority export projects (Table 4).

Table 4: EdL Generation Expansion Plan (2004-2020) for Domestic Projects and the most promising Export Projects (PSDP).

No. ¹	Project ²	Year of commissioning	Installed capacity (MW)	Active storage (Mill. m ³)
15	Nam Ngum 1 ⁱ	1972-78 (export)	150	4714
22	Huoay Ho	1999 (domestic.)	150	480
16	Nam Leuk	2000 (domestic.)	60	123
14	Nam Lik	2009 (domestic.)	100	826
18	Nam Theun 2	2010 (export)	1074	3510
17	Theun Hinboun Ext.	2010 (domestic.)	105	2870
19	Xepon	2008 (domestic.)	74	361
11	Nam Ngum 3E	2011 (export)	580	983
12	Nam Ngum 2B	2012 (export)	183	150
10	Nam Ngum 5	2012 (domestic)	90	252
9	Nam Ngum 4A	2015 (domestic.)	55	337
13	Nam Bak 2B	2018 (domestic.)	116	119
21	Xe Kaman 3	2011 (export)	250	108
23	Xe Kaman 1	2014 (export)	468	3340
20	Xe Kong 5	2017 (export)	248	2210
25	Nam Kong 3	2016 (domestic.)	25	299
24	Xe Xou	2020 (domestic.)	59	1710

¹ Numbers in this table corresponds to numbers in Map 3.

² Run-of-river projects and small reservoirs are not included.

Existing Theun Hinboun and Xeset HPPs have not been included in the analysis because they are Run of River projects. Of the planned projects Nam Mang 3, Nam Pot, H. Lamphan Gnai and Xeset 2 have not been included because the reservoirs are small.

Thailand

To our knowledge no significant hydropower development is planned in the Thailand part of the Mekong catchment, neither in the short term nor in the long-term perspective. However, some large multipurpose reservoirs have been established over the last 40 years (Table 5). According to EGAT these dams have:

- Irrigated over 240,000 acres of rice paddies
- An average annual electric energy output of 902 GWh (among which Pak Mun contributes with 280 GWh and Lam Thanong with 400 GWh).
- Served as major freshwater fish breeding grounds.

ⁱ The Nam Ngum reservoir was established as early as 1972. The discharge records in Mekong have therefore been influenced by the operation of the reservoir. In the simulation of impacts on flow and water level in Mekong (see Chapter 7) the reservoir has been included in the baseline flow record, 1950-2001. To generate a “natural” baseline record, data on real operation (inflow and outflow of the reservoir over time) would have been necessary.

Table 5: Existing Projects in Thailand within Mekong Basin (EGAT 2004).

No. ¹	Project ²	Year of commissioning	Installed capacity (MW)	Irrigation area (Ha)	Active storage (mill. m ³)
33	Nam Pung	1965	6	32000	122
30	Ubol Ratana	1966	25	40700	1695
34	Lam Phra	1967		10097	145
29	Nam Pao	1971		50416	1260
32	Sirindhorn	1971	36	24000	1191
27	Nam Oon	1973		29728	475
26	Huai Luang	1984		12800	113
31	Chulabhorn	1972	40	9600	145
33	Lam Takhong	2002	500	22000	320 / 10

¹ Numbers in this table corresponds to numbers in Map 3

² Run-of-river projects and small reservoirs are not included.

Pak Mun and Huai Kum are not included in the estimates on future water flow in Mekong since Pak Mun is a run-of-river project and Huai Kum has a small active storage.

Vietnam

A hydropower master plan is under preparation for Vietnam. Preliminary data from this study has been included here in addition to data from the “Se Kong – Se San and Nam Theun River Basins Hydropower Study” by Halcrow (1999). The projects are found on the major tributaries of Mekong, the Se San and Sre Pok rivers. The projects are listed in Table 6. The only project included in the short-term scenario would be the existing Yali.

Table 6: Existing and Planned Projects in Vietnam within Mekong Basin. (Hydropower Master Plan 2004).

No. ¹	Project ²	Year of commissioning	Installed capacity (MW)	Active storage (Mill. m ³)
37	Yali	1999	720	779
35	U. Kontum	Before 2025	220	123
36	Pleikrong	Before 2025	110	1022
39	Se San 4	Before 2025	330	470
40	D Xuyen	Before 2025	100	484
38	Ban Tou Srah	Before 2025	84	483

¹ Numbers in this table corresponds to numbers in Map 3.

² Run-of-river projects and small reservoirs are not included.

Existing Dray Ling is a run-of-river and the planned projects Se San 3 (273 MW), Se San 3A (100 MW), Boun Koup (280 MW), Srepok 3 (195 MW) and Srepok 4 (33 MW) all have small active storage. These have been excluded in the hydrological assessment.

Cambodia

Cambodia has identified some project alternatives on the Mekong and Mekong tributaries. However, it is uncertain if any of these projects are going to be constructed in the near future. The present alternatives have a low internal rate of return. Establishment of upstream reservoirs in Vietnam would however be beneficial for the projects in Cambodia. The original plans of the listed projects were controversial due to large shallow reservoirs requiring a substantial relocation of people. However, more recent studies (Halcrow, 1998) have identified new locations of dams with smaller reservoirs.

Table 7: Planned Projects in Cambodia within Mekong Basin.

No. ¹	Project ²	Year of commissioning	Installed capacity (MW)	Active storage (Mill. m ³)
42	Lower Se San 2D	Before 2025	185	Not available
41	Lower Se San 2U	Before 2025	153	Not available
43	Lower Sre Pok 2	Before 2025	205	Not available

¹ Numbers in this table corresponds to numbers in Map 3.

² Run-of-river projects and small reservoirs are not included.

At this stage no priority or time schedule for implementation are available for these projects. Sambor is a planned run-of-river project on the Mekong main stream and therefore not included in the analysis.

Myanmar

No hydropower projects are expected to be constructed within the Mekong River Basin in the next 20 years.

5.2.3 Summary of 5-years and 20-years Power Development Plans

The sum of current active storage and the expected 2010 and 2025 situation total for all countries are presented in Table 8.

Table 8: Existing and Predicted Active Storage Volume (mill m³) in the Mekong Basin.

	China	Lao PDR	Thailand	Cambodia	Vietnam	Total	NT2-portion
2004	624	5,194	5,529	N/A	888	12,235	-
2010	10,524	12,949	5,529	N/A	921	29,923	12%
2025	23,193	22,608	5,529	N/A	3,589	54,919	6%

The Nam Theun 2 project with 3510 mill m³ of active storage will account for a larger portion of the total active storage in Mekong in 2010 (12%) than in 2025 (6%). The average discharge into the Mekong at the outlet in Vietnam is assumed to be 14,500 m³/s or 460.000 mill.m³ per year. Hence, the total reservoir regulation coefficientⁱⁱ⁾ would be 0.12 in 2025 referred to the Mekong outlet. The contribution of NT2 to this coefficient will be 6% of 0.12, i.e. 0.007, in 2025.

ⁱⁱ⁾ The regulation coefficient (or regulation percent) is calculated by dividing total active storage upstream by total annual runoff.

The seasonal variation in flow would be reduced directly in relation to the upstream regulation coefficient. For example, in the Mekong at the border between China and Lao PDR, the variation in seasonal flow, in percentage, would be drastically reduced, almost eliminating the seasonal difference. The same would happen in the larger tributaries of the Mekong, Nam Ngum, Nam Theun and Se Kong-Se San, whereas the Mekong itself in its downstream reaches would still have a distinct difference between dry season and wet season flow.

5.2.4 *Local Perspective*

In addition to NT2, in the short-term perspective, the extension of the capacity of Theun-Hinboun by 105 MW is foreseen. The construction of NT2 would accelerate the plans for NT3, since NT3 would compensate for the loss of production at the Theun Hinboun caused by the operation of NT2. The economical benefit of NT3 would increase after inauguration of NT2.

The plan is to extend Theun Hinboun by one unit, i.e. a 50% increase in installed capacity. In addition to this, the present THB Extension project consists of a dam equal to the dam proposed for NT3 (but without the power plant). Some alternatives of Theun Hinboun Extension have been evaluated in the PSDP and the conclusion is that the most viable project is an extension of THB by one unit and construction of Nam Theun 3 dam without the large power plant at the foot of the dam.

Apart from Theun Hinboun Extension there is no hydropower development expected before 2025 that might influence the hydrology of Xe Bangfai and Nam Theun – Nam Kading.

5.3 **Transport**

5.3.1 *Introduction*

The transport sector is a dynamic sector that will induce a number of other developments – positive and negative – and might add to the impacts caused by the NT2 Project construction activities, social changes and management initiatives.

It is expected that in the future transportation improvements will be regarded as a key factor for poverty alleviation and socio-economic development in Lao PDR and in the region. Today a major share of Lao PDR government funds is channelled into the transport sector, which receives around a quarter of the total overseas development assistance. Particular emphasis has been put on improving road links between the major towns in the country.

5.3.2 *Regional Perspective*

It is not considered a priority issue to analyse transport trends in the greater Mekong perspective as part of this CIA. One exception, however, is the plans for upgrading, or revitalisation, of river transport on some stretches of Mekong, and the potential effects of changes in river hydrology. This issue is assumed to be of significance only in the long-term (20-year) perspective.

5.3.3 *Local Perspective*

Compared to its neighbours Lao PDR has a low road density per square km. The usage of the roads are still considered as light with average daily traffic (ADT) for

national roads varying between 250 and 500 vehicles and less than 50 on secondary roads.

However, traffic on Route 13 is substantially higher being the main north-south trunk road in the country. A traffic survey carried out by MCTPC in 2000, recorded ADTs from around 700 to 1000 on different sections north and south of Thakhek.

Branching off from Route 13 roads running east-west traverse and encircle the NT2 Project area. These roads will constitute factors that influence and drive social and economical developments in the NT2 Project area and beyond, adding to those created by NT2. Road improvement projects are in the process of being implemented or have been planned for the most important of these roads.

In Savannakhet the ADB supported East-West Corridor Project (Route 9) is nearing completion. The 2000 traffic survey recorded ADT figures around 700 on the section near the border to Vietnam. The improvement will substantially increase the movement of goods and people through the province. However, Route 9 is located some 100-130 km south of the NT2 Project influence area and will as such only have a peripheral effect on developments there.

The East-West Corridor Project also includes the construction of a bridge connection between Mukdahan on the Thai side of the Mekong and Savannakhet on the Lao side. The bridge is planned to be completed in 2006, that is, during the early construction phase of the NT2 Project. In relation to cumulative effects the bridge will probably be more significant than the improvement of Route 9 as it will create a conduit for cross border trade and transport that is likely to influence economic development in the NT2 Project influence area.

In Khammouane, Route 12 from Mahaxai to the Vietnamese border is being upgraded, financed by GoL. It is due to be finished in November 2004. The section between Gnommalath and the Vietnamese border has an ADT of around 300 according to the 2000 MCTPC traffic survey. Between Gnommalath and Thakek the traffic was found to be lighter with an ADT of around 100.

The upgrading of the provincial road from Mahaxai to Boualapha District (46 km) is just finished with support from SIDA. It is expected that SIDA will continue its support for community and district roads in Khammouane.

According to information obtained at the district level a new road from Gnommalath into the Phu Hin Poun NBCA is being constructed as a part of an initiative to develop ecotourism in the area. Information on the exact location of this road was not obtained.

Route 8B starting at the junction with Route 12 and traversing the NT2 Project area and the Nakai Plateau was recorded to have a considerable traffic load with an ADT of more than 300 in 2000. As the ADT figures for Route 12 indicates most of this traffic probably went to Vietnam.



In Bolikhamxai, the most important road in the NT2 context is Route 8 that runs from Vieng Kham on Route 13 through the important district town of Lak Xao and on to the Lao-Vietnamese border. The road will be surfaced for all its length. According to plans the upgrading will be finished towards the end of 2005. Across the Vietnamese border on Route 8 lies the town of Cau Treo that since 1998 has had status as an “economic zone”. In 2000 the official figure for import and export in this zone was estimated to 120 million USD, and a total of 180,000 people crossed the border for trade and tourism (Website Vietnam Business Forum, issue No.12, 2002).

Little is known of transport initiatives in the 20-year perspective. It is expected, however, that this area will provide more and more important corridors for transport of goods and people between Thailand, Lao PDR and Vietnam. This will lead to development of infrastructure and service facilities related to transport in the three provinces and in the districts on the Thai and Vietnamese side of the border.

The Integrated Regional Development Plan for the Savannakhet and Khammouane Region (JICA/CPC 2001) proposes to extend the runway and upgrade Savannakhet Airport to international status, as tourism and economic activity in connection with the special economic zone is expected to create a higher demand for air travel. It also proposes that passengers from Mukdahan in the future should utilize the airport and fly to Bangkok from Savannakhet by establishing a special in-migration control arrangement. If this proposal is indeed pursued, it is unlikely that it will be realised until some time after 2010. The annual passenger demand for the Savannakhet-Bangkok route is forecasted to be around 39,000 in 2012 and 63,000 in 2017

Thakhek is among the alternative locations for a future Mekong bridge after the construction of the second friendship bridge at Savannakhet is finished in 2006. The Thai authorities have already indicated interest in a Nakhon Phanom-Thakhek bridge, and it is likely that it will be realised within the time period 2010-2020.

5.4 Irrigation

5.4.1 Introduction

Apart from hydropower, irrigation is the sector with the biggest potential to exert impacts on hydrology and flow regimes in a river basin. Depending on the management, as well as the technical standard and technological level of an irrigation scheme, water consumption can vary considerably. In addition to impacts on hydrology, irrigation may also have ramifications for water quality, biodiversity and soil fertility in terms of salinisation problems.

In a cumulative impact context it is relevant to focus on the Mekong Basin as water abstractions for irrigated agriculture may possibly add to the hydrological effects created by NT2 in the Mekong mainstream, the Great Lake and the Delta. In relation to cumulative impacts, it is the water abstraction for irrigated agriculture during the dry season that is of highest interest and significance as the abundant rainfall during the rainy season makes only partial irrigation necessary. Thus the dry season irrigation will counteract the increased dry season flow caused by storage hydropower. Rice is the most important crop to focus on because irrigated dry season rice requires around 3 times more water than other field crops.

5.4.2 Regional Perspective

Irrigated agriculture is responsible for 80-90% of the water abstractions from the Mekong Basin and it is utilized in the form of receding flood water storage, pumping and diversions from rivers and streams including the Mekong, and to a smaller extent, by pumping of ground water resources.

Present areas used for dry season irrigated rice in the Lower Mekong Basin vary considerably between the countries with the largest areas found in Cambodia and in the Mekong Delta. In the Mekong Delta triple rice cropping is common with two harvests in the dry season and one in the wet season. It should also be noted that probably less than half of the area of irrigated dry season rice in Cambodia is fully irrigated. The rest of the area is recession rice receiving supplemental irrigation consuming less than half of the water consumed by fully irrigated rice.

Table 9: Irrigated Dry Season Rice the LMB and Predicted Increase (km²)

Type of Crop/Land	Thailand	Lao PDR	Vietnam Central Highland	Mekong Delta	Cambodia	Total
Irrigated dry season rice (2000)	1,070	920	370	34,030 ¹	2,510	38,900
Predicted situation (2025)	1,200	2,000	400	35,700	5,000	44,300
Increase	10%	100%	0	5%	100%	14%

Source: Lower Mekong Basin, Future Trends in Agricultural Production (MRC, 2003)

¹ Includes double cropping in dry season

The potential for expanding dry season irrigated rice is also unevenly distributed between the countries. In the lowlands of Northern and Northeast Thailand it is assumed that the future dominant production will be low input, low risk, wet season, rainfed and irrigated rice production. Irrigated dry season rice did not increase from 1990 to 2000 and substantial expansions of the area in the future is expected to be limited unless the economic returns from irrigated rice are improved either through technological advances such as higher yields or higher farm gate prices. However, there are still some land areas that may be developed for irrigation, both in northeast and northern Thailand although of varying soil quality. Limited parts of these areas are currently being developed or planned for irrigation. Seen against this background a fair guess of the future expansion is that it would be limited to 10% of today's area over a 20-year perspective. That would mean an additional area of around 100 km².

A large percentage of the potential arable land has already been converted to agricultural purposes in the Vietnamese part of the Mekong Delta. Of the total area of flat land and gentle slopes 88% is utilised for agriculture and settlements. Both the lack of suitable land and the limited profitability of growing rice presently discourages further expansion of dry season rice cropping in the Mekong Delta. Instead, the current trend is to devote land to more profitable productions like fruit trees and fish ponds. Thus only small increases in dry season rice cropping can be expected in the future, possibly limited to around 5% in the next 20 years.

The Central Highlands of Vietnam is also in a similar situation as regards land utilization and potential for increased irrigated rice area. Conversion of land for agricultural purposes is likely to continue with a focus on orchards and other pro-

ductions that give higher returns than rice cultivation. The future expansion of irrigated dry season rice in the Central Highlands of Vietnam is therefore likely to be limited.

The countries that possess the largest and most significant potential areas for expanded rice cultivation are Lao PDR and Cambodia. Lao PDR has approximately 27,000 km² ha of flat and rolling land, which could be utilized for agricultural purposes. A high percentage, possibly as high as 50% of the soils of this land type are infertile and poorly suited for agriculture but there are possibly nearly 10,000 km² ha of more fertile land (MRCS, 2003). Most of these high potential areas are located on floodplains of the Mekong tributaries in the central and southern part of the country. The expansion of dry season irrigated rice farming will in the future mostly be on a combination of already existing wet season rice areas and reclamation agricultural land. The pace of the dry season irrigation rice expansion will depend on the availability of water and investment capital for building of new schemes. Given the ample availability of suitable land a doubling of today's area within 20 years may be possible. This would mean an area of around 2,000 km² of dry season irrigated rice in 2025.

In eastern and southern Cambodia more than 4,600 km² of relatively good agricultural land are located on the Mekong floodplain. However, much of the land in Southern Cambodia is flood prone. In the Great Lake region around 7,500 km² of reasonably fertile land can be found but much of the potential land is either isolated or consist of flat areas where water storage is problematic. Still, Cambodia possesses the largest potential for expanded dry season irrigation of all the Lower Mekong Basin countries and it is thus not unrealistic to a considerable expansion in the future. Within a 20-year period one could possibly expect to see a doubling of the irrigated dry season rice also in Cambodia if capital becomes available. That would imply an additional area of around 2,500 km² by 2025.

5.4.3 *Local Perspective*

In the local perspective the Xe Bangfai, the Nam Kading and the Nam Hinboun basins are in the centre of interest as they will be experiencing changes in the flow regimes that may affect the basic conditions for developing irrigation, in particular dry season irrigated rice. As a result of the interbasin transfer of water caused by the NT2 project, Nam Theun, Nam Kading and Nam Hinboun rivers will experience reduced flows while the Xe Bangfai will receive the additional water. Table 10 gives an overview of the existing irrigation schemes and potential for expanding wet and dry season irrigation in the various basins. The information has been compiled from MRC's database on irrigation in the Lower Mekong Basin. This database relies on information received from each member country.

Table 10: Existing Irrigated Land Potential Increase in the NT2 affected Basins

Basin	Existing Irrigated Rice (ha)		Potential Increase - WS		Potential Increase - DS	
	WS	DS	ha	%	ha	%
Xe Bangfai	22,720	16,004	14,140	62	9,375	58
Nam Hinboun ¹	6,040	4,496	5,200	86	3,345	74
Upper Nam Theun ²	445	445	196	44	196	44
Nam Nyuang ³	128	90	-		-	
Nam Phao/ Nam Kata ³	1,475	1,248	1,309	89	1,109	89
Pak Kading – Xe Bangfai, riverine, Lao	4,789	3,706	4,045	84	3,174	86
Pak Kading – Savannakhet, riverine, Thai	15,885	-	-		-	
Total	51,482	25,989	24,890	48	17,199	66

Source: MRC, 2001 (WS = wet season, DS = dry season)

¹ Includes the reach above the confluence Nam Hai–Nam Hinboun

² Nam Theun south of Nam Nyuang

³ Tributaries to Nam Theun

As can be seen from the table there exists considerable potential for expanding the irrigated area both in the wet and dry season in the Xe Bangfai basin. A 62% increase appears to be possible for the wet season rice while for the dry season rice the potential amounts to a 58% increase.

The Nam Hinboun Basin, which also includes areas upstream of the confluence of Nam Hai and Nam Hinboun, has considerably smaller areas of irrigated and potential irrigated rice areas than the Xe Bangfai Basin. Still the potential for expansion of wet and dry season irrigated rice areas is considerable, amounting to 86 and 74% for wet and dry season rice respectively. However, due to regular flooding, irrigation schemes in the lower reaches of Nam Hai and Nam Hinboun are vulnerable to long periods of high water.

Existing irrigated and potentially irrigable areas are very limited along the Upper Nam Theun. On its tributaries existing and potential areas are larger, especially along the Nam Phao and Nam Kata.

Due to the topographic features of Nam Kading Basin only some limited existing areas with potential for expansion are found along tributaries joining Nam Kading close to its confluence with Mekong. These areas are included in the figures for Pak Kading-Xe Bangfai riverine irrigated and potentially irrigable areas.

The irrigation potential in connection with the Nam Theun 1 Hydropower Project is unlikely to be realised as Nam Theun 1 involves the building of a high dam that makes the project both economically marginal and environmentally doubtful. It is therefore not included in the 20-year plans for hydropower development in Lao PDR.

Because of the high potential for expanded irrigation in the Lower Xe Bangfai, the GoL has designated it a priority area for agricultural development. However, severe and protracted flooding in the wet season presents a serious obstacle to development of irrigation in the area as submergence of rice plants for more than a few days (up to 7 days depending of water velocity and sediments) will kill the crop.

The World Bank Agricultural Development Project (ADP) that started in 2001 and is presently working in 4 southern provinces including Khammouane, will construct 4 irrigation schemes in the province. Details on location and size are given below.

Table 11: ADP Planned Irrigation Schemes in Khammoauane

Scheme Designation	District	Status	Service Area ha
Phandeng	Gnommalath	Bidding	100
Naphoxay	Gnommalath	Design	80
Thathot	Gnommalath	Design	280
Nakosin	Thakhek	Bidding	70
Sangom	Thakhek	Bidding	280
Total Service Area			810

The ADP Project will also train water user groups and improve rules and regulations ensuring more gender balance. Other project components are construction of village access tracks, improvement of water supply and sanitation, strengthening of agricultural extension at district level and micro-finance provision. The ADP is due to last until 2007.

5.5 Water Supply and Sanitation

5.5.1 Introduction

Water supply and sanitation has in this study been handled both as a development sector and a sector that might be impacted by the cumulative impacts. As a development sector focus is on water demand and the withdrawal of water from surface and groundwater sources and on the discharge of polluted wastewater back into rivers and lakes. As an impacted sector, which is discussed in Chapter 7, focus will be on the how other water users might have an impact on the availability and quality on water for drinking water supply.

For the analysis of cumulative impacts, water supply and sanitation development are most relevant in the large scale Mekong River Basin and in the local perspectives of the Nakai Plateau and local river basins.

5.5.2 Mekong Perspective

Reported per capita use and demand of water for domestic purposes varies between the countries and between different studies. Demand studies have used assumptions of up to 100 m³ per capita per year, which sounds very high in countries where a large part of the population lives in rural areas with underdeveloped infrastructure. Also the population growth figures for the individual countries vary, which also results in different scenarios for future water demand.

Table 12 shows estimated population and domestic water demand in the Lower Mekong Basin by 2025. The table is based on figures from documents produced for the MRC Basin Development Plan and Water Utilization Programme.

Population growth rates in the Lower Mekong Basin are expected to decline in the future, mainly because of general economic growth and family planning.

Table 12: Population Increase and Water Consumption

Country	Population 2000	Growth rate %	Population 2025	Demand per capita m ³ /year	Total demand 2025 mill m ³
Cambodia	9,800,000	2.3	17,303,000	12	208
Lao PDR	4,905,000	2.6	9,318,000	20	186
Thailand	23,130,000	1.0	29,663,000	24	712
Vietnam	16,920,000	1.4	23,952,000	42	1,006
Total	54,744,000		80,235,000		2,112

Source population figures: MRC-BDP Regional Sector Overview 2002
Source water demand estimates: MRC Water Utilization Programme, 2002

The estimates show that the population may reach 80 million people by 2025 corresponding to a water demand of around 2,100 million m³. This translates to an average loss of flow of about 70 m³/s in the Mekong Delta. The need for more water can be counteracted to some extent by improvements in efficiency of supply and leakage reduction in the distribution network. Appropriate pricing of water is also an important countermeasure against excessive use and wastage.

5.5.3 Local Perspective

Under the ADB Water Supply and Sanitation Sector Project there are plans to build two water supply schemes in Bolikhamxai and Khammouane. One scheme will serve Nongbok Town, which is situated in the lower Xe Bangfai Basin and thus within the direct impact zone of the NT2 Project. The other scheme will be built at Lak Xao to the north of the NT2 Project area. At Nongbok, the Xe Bangfai will be used as the source for the planned water supply scheme, and by 2010 an average consumption of 17 litres per second is expected.

For Lak Xao the feasibility study is yet to be done and it has thus not been decided whether river water or ground water will be used. However, given current preferences for technical solutions among the government agencies responsible for water supply, it is most probable that surface water from a nearby river, possibly the Nam Phao, will be chosen.

5.6 Urban Development

5.6.1 Introduction

Economic development generally generates urban development. At the same time urban development can be seen to be a factor that enhances economic growth and in that way reduces poverty. Urbanisation can to some extent be planned and controlled but more often the urbanisation process is determined by general economic development and social preferences in the population. The general standard of living and services will in most cases be better than in rural areas. However, uncontrolled urbanisation often creates destitute and unhealthy slum areas lacking safe water supply and sanitation facilities, social services, etc.

In the context of cumulative impacts assessment, urban development processes in local towns and areas are considered to be the most interesting and relevant

focus as it is here the factors that drive urban development will add to those of NT2.

5.6.2 Local Perspective

Population Growth

The important urban areas to consider in the cumulative impact analysis are Thakhek, Gnommalath and Mahaxai in Khammouane, and Lak Xao in Bolikhamxai. Gnommalath district does, in a strict sense, not have any urban area, only a number of villages along or nearby Route 8B from where it crosses Nam and northwards. These villages include Gnaommalat, the administrative centre, Gnommalath Tay, Ban Hua Khua, Somsanok, Ban Nong Saeng and Keovilay. According to the 1995 census this cluster of villages had a population of around 1700 –2000 people.

Of all the districts surrounding the NT2 project area Mahaxai has had the largest growth in population with an average 3.6% per year. Growth has been more moderate in neighboring Gnommalath with only 2.3 % over the last years. As for the population growth in the district centres it may be assumed that it has grown at a higher rate than districts because of immigration.

Thakhek, the provincial capital and largest urban area in the Khammouane has experienced an average annual population growth of 3.5 % over the last 8 years. A considerable part of it can be attributed to migration as the natural population growth for in the area can be assumed to have been around or below 3%.

Nakai District on the whole has seen an annual growth of around 3% from 1995 to 2003 while Odoumsouk or Nakai Town has grown at rate of 4.8%. This rapid growth is probably due to the establishment of Nakai as a separate district and the vigorous logging activities that took place on the Plateau throughout this period.

Lak Xao, the administrative centre town in Khamkheut District is the only town in the area north of the NT2 Project area. It is a fairly large district town in the Lao context and its growth over the last years has been estimated to 2.7% annually (Norconsult, 2003)

Table 13: Urban and Rural Population in NT2 Influence Area

Area/Town	Population		Annual Increase - %
	1995	2003	
Thakhek Town (urban area)	25,768 ¹	33,017 ²	3.5
Nakai District	15,635 ¹	18,812 ⁴	2.5
Odoumsouk (Nakai Town)	1,530 ^{3a}	1,900 ^{3b}	4.8
Mahaxai District	22,982 ¹	29,587 ⁴	3.6
Gnommalath District	21,607 ¹	25,612 ⁴	2.3
LakXao		12,774 ²	2.7

Sources: ¹ NSC Census, ² Lao Urban Data Book, ^{3a} SDP (figure for 1998),

^{3b} SDP, estimate based on no. of HH, ⁴ Data obtained at district level 2004

Projected Growth in Urban Areas

Thakek will continue to be a focal point for urbanization in the province in the future. The economy of Thakhek has to a large extent been fuelled by the timber industry that currently is experiencing a recession. However, because of its size and with the economic momentum of larger growth in other sectors like trade, service and tourism, Thakek will most likely continue to experience a relatively rapid population growth and associated urban expansion. One of the factors that in the short term perspective will contribute to maintain the rapid growth of Thakek and counteract the economic slump caused by the decline of timber industry, is the effect of the NT2 Project. A reasonable assumption will therefore be that Thakek both in the short and long perspective at least maintains a growth of 3.5%.

The economic perspective of Lak Xao is linked to the forestry industry and the cross-border trade with Vietnam. The forestry related activities are declining in Khamkheut but trade and traffic associated with the upgrading of Route 8 will most likely increase. Since there are no other towns in the area it is expected that urbanization in the eastern area of Bolikhamsay will focus on Lak Xao. In addition come the effects created by trade and traffic in connection with the construction of the Nakai Dam. Lak Xao will therefore continue to experience a high growth rate, probably slightly higher than in the past. A reasonable estimate would therefore be that future growth in population will be around 3% on an annual basis.

The future growth of Oudomsouk will be dominated and governed by the NT2 Project activities in the short-term perspective. As long as there are considerable construction activities on the Plateau this will uphold the rapid growth seen in the past. One workers camp with possibly as many as 800 workers will be located near the town. It must be expected that the associated influx of camp followers, employment seekers and small-scale business people will be as least as high. In addition comes the establishment of all the administrative offices with their staff and families. A rough prediction would therefore be that the population of Oudomsouk would be around 4,000 people by 2010 if construction activities still are ongoing. If the workers have left the population will be lower, possibly around to 3,500 people.

Mahaxai District Centre will have its own dynamic in addition to the effect of the NT2 because of the planned cement factory and its location on Route 12. The number of workers that will be employed at the factory will possibly reach 300. Assuming that the population in Mahaxai is presently around 2000 the influx of workers and followers as well as associated service activities will possibly more than double the population by 2010. From there on it may be assumed that the growth will remain high, possibly around 3%.

Gnommalath and the villages along Route 8 up to the regulating dam will experience a considerable population influx and increased urbanization pressure during the implementation of the NT2 Project. Although the 4 planned workers camps with up to 2,200 workers will be located in a forested area at some distance from Gnommalath, one can expect a rise in the population in the villages along the road leading to an amalgamation into a more contiguous urban area. The majority of these will be job seekers, traders and small scale business people trying to capitalize on the increased economic activity in the area. A conservative guess would be that the inhabitants in the area along the road could reach 2,500-3,000 at the end of the construction period, discounting construction workers. After the construction period an operators village for possibly as many as 150 employees service facilities will be established in the area. Assuming that each employee

has a family with 5 household members this will lead to a population increase of 750 after 2010. Afterwards, towards 2025, urbanisation would continue with a growth similar to that of Mahaxai.

Table 14: Estimated Population Increase in NT2 affected Urban Areas

Urban area	Estimated Growth Rate		Basis Population	2010		2025	
	< 2010	2010- 25		Pop.	% incr.	Pop.	% incr.
Thakhek	3.5	3.5	33,017 ¹	48,200	46	80,750	145
Odomsouk	-	3.0	1,900 ²	3,500	84	5,400	184
Mahaxai	-	3.0	2000 ³	4,000	100	6,200	210
Gnommalath	-	3.0	2000 ³	4,000	100	6,200	210
LakXao ¹	3.0	3.0	12,774 ¹	17,600	37	27,500	115

¹ Lao Urban Data Book (2003), ² Estimate based on SDP/RAP HH figures 2003, ³ Estimated present population

5.7 Fisheries

5.7.1 Introduction

Fishery is an important but typically not a dynamic development sector locally and in the larger Mekong region. Fisheries are important as a source of protein for a growing population and it seems that the present catch is close to or above the level of sustainability. In this perspective, the options for increased output are few and fisheries are more a sector that is at risk of being affected by other developments than a sector causing impacts to others. Typically fisheries development is not planned, but happens as a result of new opportunities and changed conditions.

5.7.2 Mekong Perspective

When the annual rains begin in late April or May, the flow volume of the Mekong starts to increase. Changes in water chemistry, temperature, turbidity and flow-volume trigger an upstream spawning migration of many fish species, but predominantly catfishes. Many of the species arrive from Cambodian riverine habitats (some species perhaps from the Great Lake) and, after traversing the rapids at the Khone Falls in Southern Lao PDR, they continue their migration further upstream into Thai and Laotian waters. Some species enter tributaries for breeding, whereas others remain and spawn in the mainstream itself.

The Great Lake (Tonle Sap) of Cambodia may be considered as the “heart” of fisheries in the LMB countries. When the annual flood-pulse in the Mekong reaches a certain level in the early wet season the flow in the Great Lake River is temporarily reversed, and water flows into the Great Lake from the Mekong. Many fish species go with it. In most years, this causes the Great Lake to expand from approximately 3,500 km² to around 16,000 km². Oxidized nutrients under dry-season conditions are released and stimulate primary production. In October-November, the size of the Great Lake begins to rapidly decrease, which causes a massive fish movement migration out of the Great Lake back towards the Mekong via the Tonle Sap River. Here large quantities are intercepted in the bagnet fisheries.

The present fisheries yield in the lower basin is shown in Table 15: Fish Yield in Lower Mekong Basin. The total includes about 240,000 tonnes produced in reservoirs and 260,000 tonnes from aquaculture. Of the 500,000 tonnes reported from Cambodia about 235,000 is from the fisheries in the Great Lake.

Table 15: Fish Yield in Lower Mekong Basin (MRCS 2000)

Country	Estimated catch per year tonnes
Cambodia	500,000
Lao PDR	133,000
North east Thailand	795,000
Delta Vietnam	597,000
Total LMB	2,000,000

There are clear signs of over-exploitation, such as decrease in the average size of the fish caught. In addition there are a number of threats to the fish production and the fish biodiversity by changes in hydrology, water quality and riverine habitat.

Based on population growth figures and maintenance of the same level of fish consumption as today the demand for fish in LMB will grow from today about 2 million tons per year to about 2.4 million tons per year in 2010 and about 2.9 million tonnes per year in 2025. It is not likely that the natural production potential will allow for such an increase in output. The challenge will more realistically be to protect the production potential and to define and control the level of sustainable exploitation.

Aquaculture is an emerging activity in the region. Aquaculture has often been promoted as an alternative to the damage caused by hydropower and irrigation projects. However, only under certain circumstances can small-scale, extensive, village-level aquaculture compensate for losses to "wild" fisheries. This is mainly due to the economics of small-scale systems, lack of technical "know-how", poor access to credit, marketing problems, flooding and the costs involved in pond or net cage construction.

5.7.3 Local Perspective

Realistic figures for fish production in Xe Bangfai, Nam Kading, Nam Hinboun and their tributaries are near to impossible to obtain. The factors that actually affect the ultimate fisheries production in any particular year are both related to the fishing activities (including destructive fishing methods and over fishing) and natural factors determining production and migrations (flood levels, catchment deforestation, lunar cycles, "flash-floods", water temperature, turbidity and chemistry, etc.)

The current on-going pre-impoundment study of Xe Bangfai records weekly quantitative data on fish catch from 21 fishers living in seven villages. The estimate for the 2001 to 2002 period, based on reports from 21 "Project" fishers is that a family (household) can obtain on average 255 kg of fish per year. How this figure from "professionals" relates to the average catch of fish for all households in the total area has not been established. It is not known whether the present

catch level is close to the carrying capacity of the fish populations or if there is room for increased catch in the future. No specific plans have been identified during this study for fisheries or larger scale aquaculture development in the Xe Bangfai, Nam Kading or Nam Theun basins.

In the Nakai reservoir area the new “lake” is likely to create opportunities for commercial fishing activities. The social development plans have included requirements for giving the local population the priority in utilising this potential.

5.8 Forestry

5.8.1 Introduction

In this section, forestry as a commercial development sector based on the exploitation of timber resources is described. Sustainable forest management as an activity to conserve forest biodiversity and promote small-scale/traditional forest product utilisation is a sub-sector that might be impacted by commercial logging and other development activities in the area. Such impacts are discussed in Chapter 7.

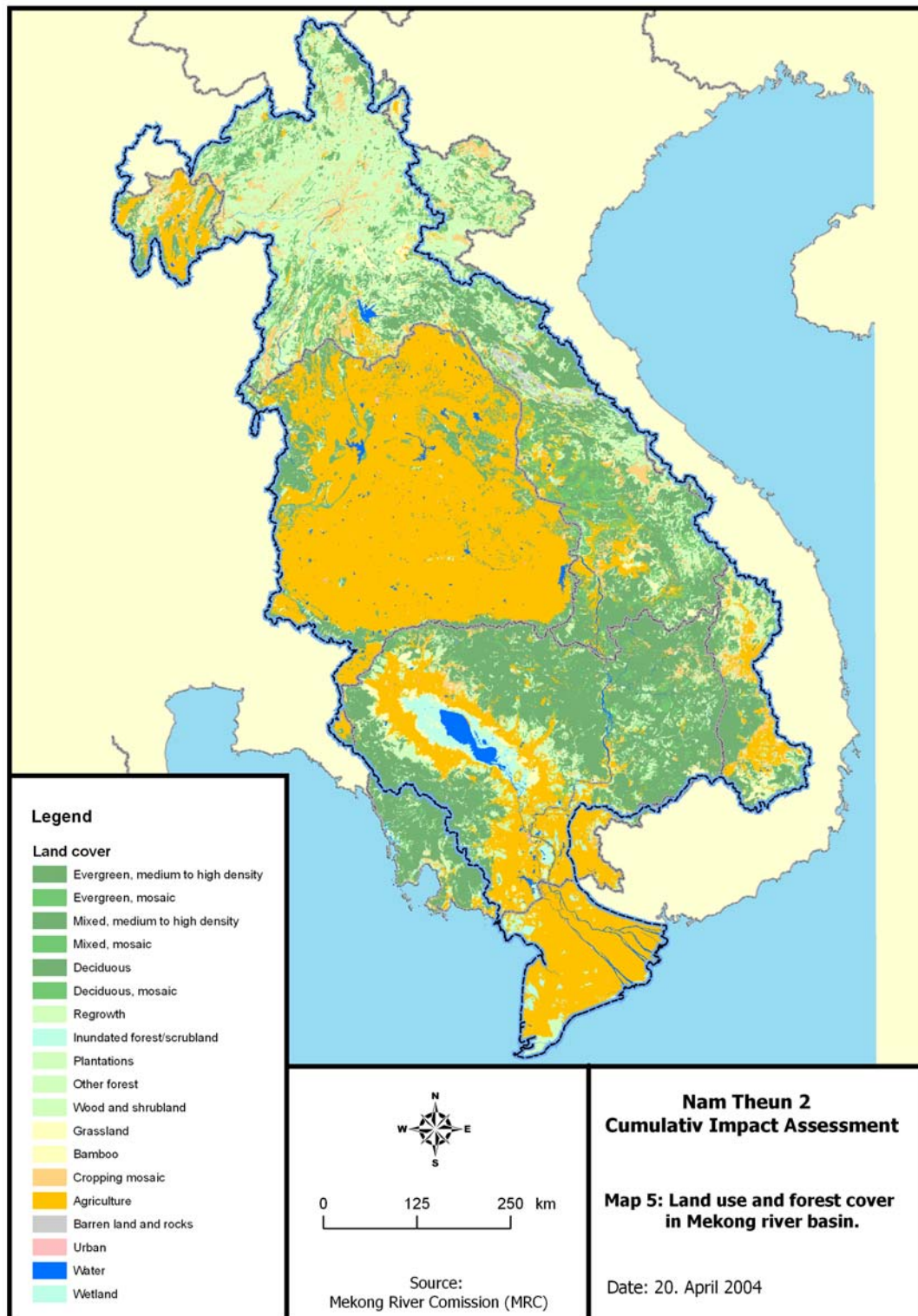
Most of the forestry related impacts would be felt in the local impact areas covered by this CIA. However, the general basin wide trend in forest coverage and forest types might have an impact on the area water runoff pattern and thus the hydrological regime for the whole Mekong Basin.

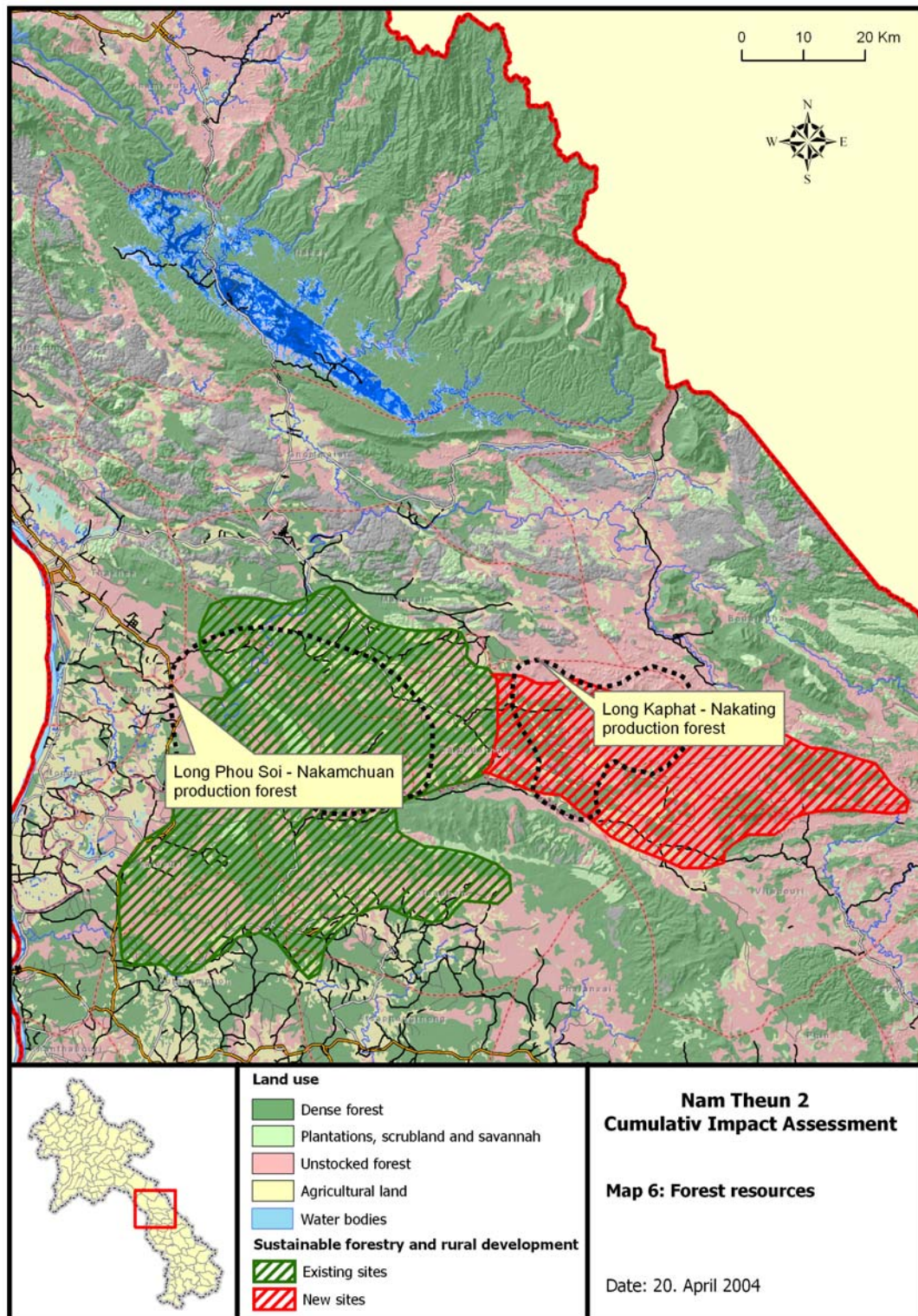
5.8.2 Mekong Perspective

The remaining forested area in the lower Mekong is largely found in Lao PDR and Cambodia. There is however, also some forest left in the Vietnam and Thai parts of the basin. The following figures for forest cover have been calculated on the basis of the Mekong River Commission’s GIS database.

Table 16: Forest Cover in the Mekong Basin (MRC 1997)

Country	Total area (km ²)	Forest area (km ²)	Forest cover
Cambodia	181,547	97,748	53.8%
Lao PDR	229,786	88,012	38.3%
Thailand	188,280	29,597	15.7%
Vietnam	67,456	14,127	20.9%
<i>Total</i>	<i>667,069</i>	<i>229,484</i>	<i>34.4%</i>





The MRC figures diverges somewhat from those in forestry strategy for Lao PDR. (MAF 2003). The discrepancy may be due to different forest definitions. Lao PDR has over the last decades seen a relatively rapid reduction of its forest cover from 64 % in the mid-sixties to 41.5% today measured as forest with more than 20% canopy density. Although the stated goal is to increase the forest cover substantially it is to be feared that the trend of diminishing forest cover will continue also in the years ahead. If the decline continues at the same rate as the last 35-40 years the forest cover will be down to 37-38% in 5 years time and down to around 30% in 20 years time.

Cambodia is the country with the highest forest cover of the Mekong basin. Also here, logging has been conducted on a large scale over the last decades. A reasonable assumption would be that this trend also continues into the future. The forest cover could thus be considerably reduced, perhaps to somewhere between 47 and 50% in 5-years time, reaching below 40% in 20 years time.

Having been reduced to just 15-16%, significant further reductions should not be expected in Thailand. In Vietnam increased agricultural activities could reduce the forest cover down towards 15% in the 20-year perspective

5.8.3 *Local Perspective*

It is assumed that the significant cumulative effects of developments in the forestry sector and the NT2 Project will primarily occur in the NT2 Project area itself and in adjacent forested areas such as the NBCAs.

The timber harvesting and logging industry has been one of the major sources of employment in Khammouane Province with around 5000 people engaged in it during its peak in the last half of the 1990s. In 1996 there were 9 privately owned sawmills, 5 joint venture sawmills and 1 kiln-drying facility in the Khammouane and Bolikhamsay Provinces relying on logging in Khammouane. These facilities had a combined intake of around 325,000 m³ per year. In addition there is a plywood mill (near Mahaxai) and a chipboard factory in Khammouane with a combined intake of 100,000 m³ per year.

There are 2 designated production forest areas in Khammoauane Province, each of around 60,000 ha. These are the Dong Khaphat-Nakating area located in the southeast between the Khammouane-Savannakhet border and the Xe Bangfai, and the Dong Phou Soi-Khamchouan located in the southwest between Route 13, the Savannakhet border and the Mahaxai-Xaibouathong road (see Map 6).

It has been estimated that from 2005 the annual supply from these lowland production areas will be about 100,000 per year (IUCN, 2000b). The timber and wood supply in Khamouan will thus be seriously deficit in relation to the current capacity of the wood processing industry. In fact, diminished wood supply has already led to a contraction in the industry and number of people employed in it.

In Boulikhamsay 8 sawmills and timber processing mills were operating in the province around year 2000 with a combined processing capacity of around 100,000 m³ per year. In addition, a large integrated wood-processing plant has been constructed at Lak Xao. The production capacity of this plant is assumed to be around 250,000 – 300,000 m³ per year

Today there is only one production forest area in Bolikhamsay Province with a potential yield that is far less than the current installed production capacity of the processing industry.

An initiative to improve sustainability in the forestry sector is the SUFORD project currently being implemented in Khammouane, Savannakhet, Salavan and Champassak. The project will work in 3 districts in Khammouane. Two of these, Mahaxai and Xe Bangfai, are located in also the NT2 impact zone. The 2 production forest areas form part of the project area.

The project components include capacity building and sustainable forest management with demonstrations of management practices in the field including active participation of villagers. The field implementation will cover 528,000 ha of natural forest whereof 110,000 are in Khammouane Province. The implementation period started in 2003 and will continue until 2007.

Another potentially important factor that will influence the forestry sector in the future is the development of tree plantations with fast growing species suitable for industrial use. The BGA Company is presently developing a total area of 154,000 ha in Bolikhamxai Province. One third will be planted to mainly *Eucalyptus camadulensis*. The plantation area is divided in several sub-plots situated between the Mekong and the mountain range from Pakkading in the north to the mouth of the Hinboun River in the south.

5.9 Industry

5.9.1 Introduction

The industrial development activities that might contribute to cumulative impacts will primarily be activities on the provincial level. Basin-wide development might in the long run have an impact on Mekong River water quality but so far the wastewater discharges are insignificant compared to the recipient capacity of the Mekong.

5.9.2 Local Level Developments

In terms of industrial production, Savannakhet is second only to Vientiane on the national scale. The factories and enterprises are concentrated in Savannakhet town and adjacent areas and comprise the production of electrical appliances, tobacco processing, canning of fruit based products and textiles. The establishment of a special economic zone is likely to attract more enterprises to the province.

Possible future developments include an oil refinery and terminal that will have the capacity to cover 50 percent of the country's consumption. It is not known at this stage how likely it is that the refinery will be constructed. If it becomes a reality it will probably not be built before 2010.

Wood processing (sawmills, etc) is the dominant industrial activity in Khammouane with a total of seven registered enterprises in 2001. The existing sawmills represent a considerable overcapacity. The present output of the plywood factory at Mahaxai is probably much lower than its intended capacity. New establishments are not expected within wood processing. In this sector consolidation is required, and focus is likely to be on value added processing from those enterprises that will be allowed to continue to operate. It is likely that sawmills not able to meet new requirements will be shut down.

A new cement factory is planned to be constructed in Mahaxai District. The construction work is planned to commence in November 2004 and a two year construction period is expected. 300 workers are expected to be employed on a permanent basis by the factory.

ounces in 2005 and to nearly 400,000 in 2007. Total reserves of gold are estimated at 2.09 million ounces.

Production of copper from their Khanong mine located in Xepon District is expected to start in the first quarter of 2005. A production plant with a capacity of 60,000 tons per year is currently being build at the site. The Khanong mine is estimated to contain 1.21 tons of copper. The Power System Development Plan from 2004 has included the production plant's energy need in their in their demand forecast, amounting to 40 MW from 2005.

The social and environmental impacts of the copper mine and the production plant are expected to be considerable. The Environmental Impact Assessment for this project is presently under review by STEA.

5.11 Social Development

5.11.1 Introduction

Social development comprises a number of sub-sectors and factors, which together affect living conditions, incomes and the general well-being of a population. Health and education services are prominent elements in a social development process while economic growth augments household incomes and employment opportunities. Another important element is the issue of poverty alleviation, which aims to ensure an equitable distribution of resources and economic opportunities. Related to this are the issues of ethnic minorities, vulnerable groups and gender.

In the context of this CIA the social development factors are most relevant for the national and local geographic perspectives.

5.11.2 National Perspective

It is expected that on a national level the NT2 project will create an important precedence for the mitigation of social impacts within the context of future infrastructure development in the country. This relates to the overall participatory approach to planning and implementation, legal issues and specific plans that target ethnic minorities and other vulnerable groups. Countrywide plans for social development in terms of improved health and education services will have a bearing on local level and project area developments, but these impacts do not warrant a cumulative impact analysis on national level.

5.11.3 Local Perspective

Health

The health situation in the NT2 intervention area has been investigated and described in numerous project sponsored studies and reports. Data from these studies, coupled with data and information obtained from national and provincial health statistics, are presented in Table 17. Together with they provide a picture of the health status of the population at national level and in the NT2 influence area.

Table 17: National Level and NT2 Area Health Data

Indicator	National and Provincial Rate	National Ranking
-----------	------------------------------	------------------

	Nat.	KM	BLX	SVK	KM	BLX	SVK
Natural Growth Rate (%)	2.8	2.6	3.3	3.1	5	14	11
Infant Mortality Rate (infants < 1 year per 1,000 live-births)	82.2	91.5	26.0	98.7	5	14	11
Under 5 Mortality Rate (children < 5 per 1,000 live-births)	106.9	116.2	47.7	123.9	15	2	17
Malaria Morbidity ¹ (no. per 100,000 patient)	48.5	104.7	44.9	61.5	-	-	-
% Households with water supply	50.0	38.0	65.0	66.0	-	-	-
% Households with latrines	29.0	14.0	22.0	11.0	-	-	-
Acute Respiratory Illness (% of children < 5 years, estimated)	5.5	10.7	4.9	11.0	-	-	-
Diarrhea incidence (% of children <5 years, estimated)	2	2.8	2.8	2.5	-	-	-
HIV Infected ¹ (no. of persons)	1,102	92	9	487	-	-	-
AIDS cases ¹ (no. of persons)	599	17	9	286	-	-	-

KM=Khammouane, BLX=Bolikhamsay, SVK= Savannakhet

¹Source NCCA, figures for June 2003

As can be read from the table the health situation in the provinces surrounding the NT2 Project are in many respects poorer than the national average. The exception seems to be Bolikhamsay which according to a number of key indicators, e.g. Infant mortality rate and diarrhea incidence, performs better than the national average. However, it should be noted that the statistical basis for calculating indicators sometime is very weak and thus, it should be cautioned against drawing firm conclusions on the available statistical material. It should also be noted that Khammouane appears to have larger problems with malaria than the 2 other provinces. The HIV/AIDS epidemic have so far affected Savannakhet most severely with nearly half of all AIDS cases in the country occurring in the province.

In terms of health staff and facilities in Khammouane province the situation varies from district to district.

As Table 18 shows the central zone along the Mekong and Thakhek are the districts with best coverage.

Table 18: Existing Health Infrastructure in Khammouane Province

District	Health Office Staff	Hospitals		Health Centres	
		Beds	Staff	Number	Staff
Thakhek	18	150 ¹ / 26	17	12	41
Mahaxai	17	15	17	6	7
Nongbok	21	15	29	10	20
Hinboun	20	15	14	17	36
Gnommalath	22	15	14	5	6
Boualapha	16	15	22	3	11
Nakai	13	15	12	5	11
Xe Bangfai	24	15	13	6	14
Xaybouathong	14	15	16	3	7

¹ Provincial Hospital

A Public Health Action Plan financed by the NT2 Project will be implemented in order to reduce and prevent expected negative health effects in connection with the NT2 Project. It will cover all Project impacted zones from the Nam Theun watershed to the lower Xe Bangfai area. The Plan includes interventions to prevent respiratory diseases, HIV/AIDS, water and vector borne diseases including malaria as well as psychosocial problems like substance abuse, depression and violence. Health infrastructure will be improved by developing the main project medical facilities at the Nakai District Hospital for treatment and stabilization of worker injuries and illnesses within the Oudomsouk Work Camp Zone and the Gnommalath District Hospital for workers at the power station.

Education

Lao PDR allocates 2.4% of its GDP to education. In 2001 the net primary school enrolment rate had reached 80 percent, up from 62 percent in 1990. The Government aims at achieving full enrolment before 2015.

In general the education sector in Lao PDR suffers a lack of funds for salaries and schooling facilities, and a lack of qualified personnel. This situation is most pronounced in the more remote parts of the country in the north and the south. This situation is exacerbated by the fact that the population is young and the majority of school age children live in rural areas. Years of schooling average 2.9 - 3.6 for boys, and 2.1 for girls.

In terms of spending on education Khammouane Province allocated around 1.8 million Kip per student in 2000 (JICA/CPC 2001). Among all 18 provinces in Lao PDR Khammouane was the third lowest. Vientiane and Sekong spent most per student with around 9 million Kip. Some indicators for the education sector in Khammouane Province are shown below.

In Bolikhamxai the construction material industry dominates. In 2001 there were seven enterprises providing gravel and sand for different types of construction and building activities. Wood processing and production of mirrors also takes place. A notable enterprise is the extraction of chemical compounds from wood (Mai Ketsana) for use in the production of incense sticks and cosmetics.

5.10 Mining

5.10.1 Introduction

Similar to industry, the mining activities that might contribute to cumulative impacts will primarily be activities on the provincial level. Basin wide development might in the long run have an impact on the Mekong River water quality but so far the wastewater discharges are insignificant compared to the recipient capacity of the Mekong.

5.10.2 Local Perspective

Located on the Nam Pathen tributary to the Nam Hinboun there are mines producing heavy metals like tin, lead and zinc. Some of the mines have been in operation for decades, but it is difficult to get any precise information about the level of activity and the processes used. Recent observations, however, indicate that the settling pond systems and pollution control is of a very low standard. There is presently high activity at the mines and it contributes significantly to pollution problems in Nam Pathen and the lower part of Nam Hinboun. High levels of turbidity can be observed. Regular monitoring is not carried out but one sample from July 1995 shows high levels of several heavy metals including lead, zinc, tin and cadmium. The content of iron was extreme (18,700 µg/l compared to the WHO and Lao PDR standard of 300 µg/l). In the same period the iron concentration in the lower Nam Hinboun also exceeded the water quality standards (NORPLAN 1997). There is a concern that the mining activity leads to high concentrations of heavy metals in fish and other aquatic organisms.

Alluvial gold is found in Nam Kata a tributary to Nam Phao downstream Lax Xao. Prospects exist for commercial exploitation. At present gold is extracted by artisanal means, which includes the use of mercury. No monitoring of the potential water pollution seems to have taken place.

Gypsum is produced by the State Gypsum Mining Enterprise from the Dong Hene mine in Savannakhet Province. Proven ore reserves at the mine are estimated to be 18 million tons. Gypsum production has increased steadily in the past 4 years because of increased demand by the domestic cement industry and increased exports to Vietnam. Several limestone quarries are presently under operation in Khammouane and Bolikhamxai.

Further developments are foreseen in Savannakhet Province in a long-term perspective. The province has deposits of lead and zinc in the eastern part near the Vietnamese border that might be economically attractive to mine.

The only large-scale mining project within the three provinces that surround the NT2 project area, are the gold and copper mines in Xepon District in Savannakhet. The concession holder and operator of the mines is Oxiana Limited acting through its subsidiary in Lao PDR, Lane Xang Minerals Limited. The gold mine produced 73,247 ounces (2,076 kg) of gold and 35,622 ounces (1,010 kg) of silver the first half of 2004. Gold production is targeted to increase to 200,000

Table 19: Education Indicators for Khammouane Province 1998

Indicator	Primary	L. Secondary	U. Secondary
Number of Schools	520	46	9
Enrolment Ratio	76.4	24.8	10.6
Number of Students	47,494	6,741	2,241
Dropout Ratio	20.0	-	-
Repetition Ratio	24.0	-	-
Teacher-Student Ratio	1:31	1:13	1:11
Number of Teachers	1,509	-	-
% of Unqualified Teachers	38.0	-	-

Source: JICA/CPC, 2001

The education component in the Social Development Plan includes construction and staffing of primary schools in every resettlement village. Secondary schooling will be provided according to the needs. An adult literacy programme for the resettlement is also proposed under the plan.

Poverty Alleviation

According to the Lao Expenditure and Consumption Survey (LECS) carried out in 1992/93 and 1997/98 the incidence of poverty has declined slightly in Khammouane and Savannakhet while it in Bolikhamxai has increased substantially. However, the figures for Bolikhamxai is so much lower than the national average and neighboring provinces that some doubt can be raised about their accuracy and validity.

Table 20: Poverty Incidence by Provinces Surrounding NT2

Province	1992/93	1997/98
Bolikhamxai	10.6	25.8
Khammouane	43.7	41.6
Savannakhet	45.7	37.1
National average	45.0	38.6

Source: Interim Poverty Reduction Strategy Paper, 2001

In connection with the national poverty reduction strategy work all villages and districts in the country has been classified in relation to the calculated national poverty line. This resulted in 72 districts being categorized as poor and 70 as non-poor. Out of these 72 districts 47 have been earmarked for special priority interventions to reduce poverty.

Table 21 lists the poverty classification of the districts in the 3 provinces in NT2's influence zone.

Table 21: Poor Districts in Provinces Surrounding NT2

Province	Poor Priority Districts	Poor Non-priority Districts	Non-poor Districts
Boulykhamxay	Bolikhan Khamkeuth Viengthong		Pakkading Pakxanh Thaphabat
Khammouane	Boulapha Nakai	Gnommalath Mahaxai Xaybouathong	Thakek Nongbok Xe Bangfai Hinboun
Savannakhet	Nong Xepone Phin Vilabouly	Thaphangthong Xonnabouly Phalanxai	Xaibouly Outhoumphone Khantabouly

Poverty alleviation is now the overarching goal for the Lao Government. In the Interim Poverty Reduction Strategy Paper (I-PRSP) a broad strategy for poverty reduction is outlined. Four sectors are identified as particularly important: agriculture and forestry, education, health and road infrastructure. Improved governance and sound macroeconomic policies are identified important underlying and enabling conditions. The I-PRSP was elaborated in a national Poverty Eradication Plan presented in 2003. The Government is committed to halve poverty by 2015, which is one of the Millennium Goals adopted by Lao PDR.

In terms of poverty reduction efforts in the NT2 influence area the World Bank is currently preparing a project aiming to improve livelihoods and enhance opportunities for the downstream rural population in the Xe Bangfai Basin. The core districts will be the Gnommalath, Mahaxai, and Xe Bangfai while Boulapha, Nongbok and Xaibouly may receive more specifically targeted assistance. The project is intended to improve the local populations opportunities to benefit from the economic development that is expected to result from the NT2 Project. Interventions will include activities to improve market linkages through building an improved rural access road network and strengthening marketing organisations, improvement of natural resource management, increased agricultural productivity through diversification and extension, and, enhancing women's opportunities to participate in the economic development. The Government has also requested the project formulation team to consider interventions also in the health and education sector. Due to the funds available it has been recommended that the project does not engage in irrigation development.

Ethnic Minorities

Considerable efforts by scholars and government officials have identified a two-tiered system of ethnic classification with 49 main ethnic groups and over 100 sub-groups in Lao PDR. There are four main ethno-linguistic groups in the country: Lao-Tai, Mon-Khmer, Sino-Tibetan and Hmong-mien groups.

Although there are safeguards in the Lao constitution and the PM Degree on Ethnic Minority Policy (1992) regarding the rights of ethnic minorities, the multi-ethnic character of the country and the promotion of development for all groups, the present trend is towards assimilation to and adaptation of the majority Tai-Lao culture by minority groups in terms of livelihood, cultural practices, religion and language in the project area (EMDP, 2003). Many minority groups are consciously changing their ethnic identities in order to improve their socio-economic

situation. Education is only in the official Lao language and Tai-Lao culture stands for modernity (Buddhism as opposed to animist practices, market-oriented economy and wages versus subsistence production, government jobs versus farming, etc.).

This trend is likely to continue regarding small groups that are reliant on traditional practices such as hunting and the gathering of NTFPs, and the pace might be accelerated by development initiated by the NT2 Project. Increased demand for resources due to population influx and more competition for these resources could threaten traditional livelihood systems. However, there are larger ethnic minorities, such as the Brou with a similar livelihood system to the Tai-Lao in low-land areas and such ethnic groups have the potential to develop economically and culturally in parallel with the dominant groups.

Table 22: Ethnic Minorities in the Three Affected Provinces

Province	1995 Census Data	1997 Population Estimates		
		Total	Ethnic Minorities	%
Bolikhambxai	163,589	171,201	34,240	20.0
Khammouane	273,779	288,600	134,500	46.6
Savannekhet	671,581	711,500	302,400	42.5
3 Provinces	1,108,949	1,171,301	471,140	40.2

Source: 1995 National Census, Lao PDR

Information on ethnic minorities in the three project provinces is presented in Table 22. Over 40% considered themselves as belonging to an ethnic minority. However, many of these ethnic groups are in the process of assimilation.

The annex on Ethnic Minorities provides a detailed account of the ethnic composition of the project area and surrounding areas and maps. Table 23 illustrates the main groups and characteristics.

Table 23: Main Ethnic Groups in Project Area and Surrounding Areas

Ethnic Group	Location	Main Characteristics
Tai-Lao	Along the Mekong and dominant in urban centres	Majority group
Phou Thay	Along the Xe Bangfai and tributaries and in urban areas in Khammouane and Savannakhet Provinces	Culture similar to Tai-Lao
Tai Moey and other upland Tai groups	Bolikhamxai Province and Khamkeut, Nakai-Nam Theun NBCA and Nakai Plateau	Tai-Lao language, animist with some Buddhist influences and diverse livelihood systems
Tai Bo	Nakai, Hinboun and Khamkeut Districts	Mixed origins, possibly Vietic and other groups now with Lao culture
Lao Kaleung	Throughout the northern parts of Khammouane District	Culture similar to Tai-Lao
Sek	Small numbers of villages and households throughout the area	Ancient Tai culture, animist, knowledge of paddy cultivation
Brou/Makong	Upland areas and central parts of Khammouane Province	Dominant ethnic group in the area – different degrees of integration
Vietic Groups	Scattered small settlements mostly in remote areas and NBCAs	Vulnerable group, dependent on forests and unique culture
Hmong	Recent arrivals in northern parts of Bolikhamxai	Hmong culture is Taoist, patrilineal and reliant on swidden with some exceptions along Route 8

5.12 Conservation

5.12.1 Introduction

In this study, Conservation is presented both as a development sector and a sector that might be impacted by the cumulative impacts by NT2 and other development projects. As a development sector, focus will be on plans and initiatives for extended conservation and improved management of natural resources and biodiversity. As an impacted sector, which is mostly treated in Chapter 7, focus will be on how development projects in other sectors might impact the conservation of biodiversity.

5.12.2 National and International Perspective

Lao PDR ranks as one of the richest countries in South-East Asia when it comes to biological diversity. Unfortunately, the increasingly rapid degradation of the country's forest resources and wetlands, combined with an intense (illegal) hunting pressure and trade in endangered species continues to put undue pressure on its diversity of plants and animals. In order to counteract this negative trend, Lao PDR has initiated several important actions in biodiversity conservation.

Wetlands along the Mekong and on some of the major tributaries are of very high biodiversity value. They are inhabited by a large number of rare and threatened species and play a critical role as stopover sites for migratory birds and are key breeding areas for some of the economically important fish species. The regular flooding of the wetlands is a key factor for the fish production in the basin. The Stung Treng Wetlands, downstream of the Khone falls in Cambodia, has been given a status of Ramsar Site. Few other wetlands have been given formal pro-

tection status. None of the Lao NBCAs have been established for wetland protection per se.

No regional wetlands policy or strategy has yet been prepared. A large-scale Global Environment Facility (GEF) funded project is, however, under development by IUCN in consultation with the four Governments, UNDP, MRC and other key stakeholders in the Region. The project aims to strengthen capacity for conservation and sustainable use of wetlands in the Lower Mekong Basin.

In 1996, Lao PDR ratified the Convention on Biological Diversity (CBD). The obligations of CBD have been followed up with legal and institutional development (see chapter 3.2), as well as by the establishment of 20 protected areas (NBCAs), covering more than 33 100 km² (14 % of the land area). In addition, there are also some provincial and district conservation forests.

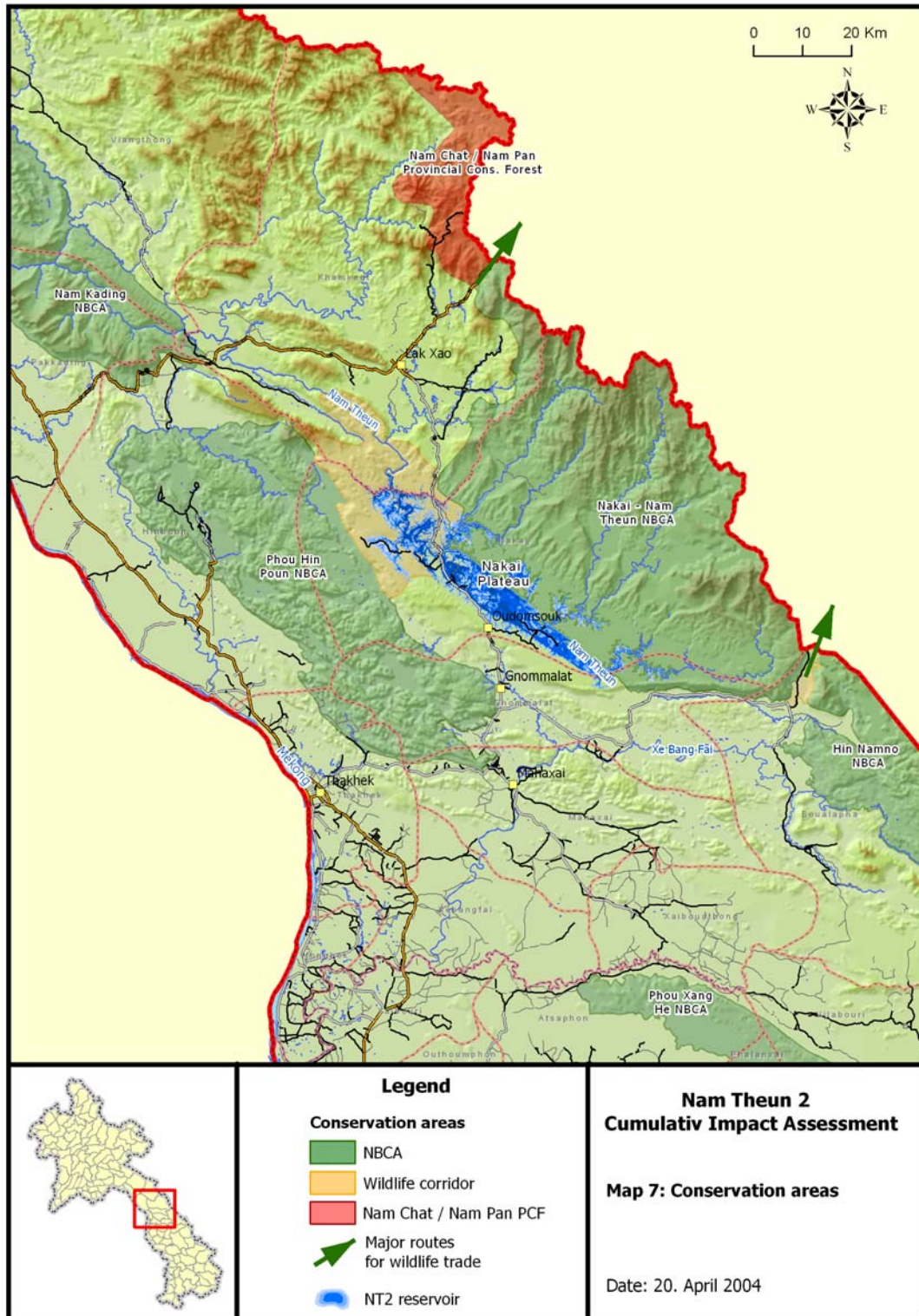
It is not a straightforward task to describe plans and likely development trends in the 5-year and 20-year perspective when it comes to biodiversity conservation in Lao PDR in general and in the affected provinces in particular. However, it seems reasonable to assume that the following national and international plans and trends will play an important role in future efforts to counteract the current trend of biodiversity loss in Lao PDR:

- There has been a decrease in foreign contributions to biodiversity conservation in Lao PDR the last three years (MAF & STEA 2003), and there are indications that bi-lateral co-operation in biodiversity conservation in the future will settle at a lower level than in the late 90s.
- As the extent of pristine nature and biodiversity in Lao PDR and its neighbouring countries dwindles, an increasing focus from international environmental organisations (WWF, WCS, IUCN, CI and others) should be expected.
- In addition to the 20 existing NBCAs, a few other areas are currently considered for future designation as NBCAs or as extensions to existing NBCAs. It is assumed that with the implementation of current plans, a limit is most likely to be reached in terms of further identification of new protected areas.

5.12.3 *Local Perspective*

Most plans and initiatives in terms of biodiversity conservation come from national authorities. GoL has officially devolved responsibility for national policy implementation to provincial governments and relevant agencies. Even though government agencies like STEA have provincial offices, they are mainly carrying out tasks that have been outlined in national plans and strategies. This means that plans and trends mentioned in the previous section also apply to the provinces influenced by the NT2 Project.

A major problem is the lack of awareness and support for biodiversity conservation among the local population. Without such support it is difficult to enforce the protection and management principles developed by central and provincial authorities.



The unique value of the biodiversity in the Bolikhamxay and Khammouane Provinces are under serious threat. In general for the NBCAs in Lao PDR logging and deforestation for agriculture is seen as the most serious threat to biodiversity. In these two provinces, however, and in particular in the western parts, wildlife trade is seen as an even more acute problem (IUCN, 2000). The centre of this trade is supposed to be Lax Xao and about 60-70 % of the goods is assumed to go to Vietnam and eventually to China.

The lower part of the Xe Bangfai plain is highly developed with little natural habitat and wildlife left. A large tract of previously forested land west of Hin Nam No NBCA has been cleared by logging, and has also lost most of its biodiversity value

Some proposed conservation initiatives, including some already implemented, can be highlighted as follows:

- The proposed extension of Nakai-Nam Theun NBCA to the north, consisting of about 450 km² largely undisturbed forest, has been gazetted as the *Nam Chat/Nam Pan Provincial Conservation Forest*.
- Forest corridors linking Nam Kading NBCA with the Phou Hin Poun and Nakai Nam Theun complex to the south have been proposed. The Nam Theun-Phou Hin Poun corridor was gazetted in 2000.
- An extension of Hin Namno NBCA to the south to cover more of the headwaters of Xe Bangfai. A corridor between Hin Namno and Nakai-Nam Theun NBCA has been gazetted.
- An extension (117 km²) of Phou Xang He to the west and south to incorporate a still largely undisturbed forest area has been proposed.

The NT2 Project will provide the Nakai-Nam Theun NBCA with annual funds of US\$ 1 million. This will be an important contribution in order to protect this globally important NBCA against further encroachment from loggers and poachers.

Wildlife Conservation Society (WCS) is planning a 5-year project in Bolikhamxai Province, co-financed by GEF. Provided that the project plans are approved by GEF, this will bring biodiversity conservation in this region an important step forward.

5.13 Development in Neighbour Districts of Vietnam and Thailand

5.13.1 Vietnam

Bolikhamxai and Khammouane provinces, including the Nakai Nam Theun NBCA, share borders with the two Vietnamese provinces, Ha Tinh and Quang Binh. Given the fact that there is already considerable regular and irregular cross-border traffic with relatively free movement of people and goods, developments on the Vietnamese side are likely to have a significant influence on the management and protection of the Nakai Nam Theun NBCA on the Lao side of the border.

Population

Ha Tinh had a population of approximately 1,270,000 out of which only 121,000 (9,5 %) lived in towns and urban areas in 2001. Population growth rates have slowed considerably over the last years and are now around 1,2%, primarily due to out-migration to other areas in Vietnam, such as Hanoi and Ho Chi Min City.

The population is forecasted to be around 1,362,000 in 2005 and 1,431,000 in 2010. Ha Tinh, located in the coastal area at the end of Highway 8, is the largest town in the province while nearby Vinh, located north of Ha Tinh across the border in Nghe An Province is the largest urban area in the region with an approximate population of around 210,000. The population of Quang Binh is around 813,000 with urban residents constituting 11%. The population growth rate 1991–2001 was on the average 1.6% and presently assumed to be close to 1.0%.

Economic Development

The economy of both Ha Tinh and Quang Binh is predominantly agriculture and forestry based with 78-79% of the labour force employed in primary productions. Industry and service are the other significant employment sectors. Over the last decade Ha Tinh and Quang Binh have seen a rapid economic growth with present growth rates around 8%. Of special relevance in relation the NT2 project is the Cau Treo economic zone created in 1998 in order to stimulate trade and economic development in the Lao-Vietnam border region and Ha Tinh Province. The zone occupies an area adjacent to the Lao border comprising the Cau Treo border crossing on Route 8, the Tay Son Town and the Son Kim commune of Huong Son District. The economic zone enjoys privileges and preferential treatment to attract investors and trade. In 2000 the official figure for import and export was estimated to 120 million USD, and a total of 180,000 people crossed the border for trade and tourism (Vietnam Business Forum, 2004). The Vietnamese authorities are planning to further develop the zone by improving market infrastructure and reducing bureaucratic procedures in connection with trade.

Transport

Ha Tinh has an extensive road network with a total length of 2,900 km, including 4 national roads passing through the province. Of particular interest with respect to developments on the Lao side of the border is Route 8 running from Ha Tinh Town, over Cau Treo and into Lao PDR.

The construction of the Ho Chi Minh Highway, which started in 2000, is a development that will influence the border region strongly. It will run inland along the border, opening up previously relatively inaccessible areas for settlement and economic exploitation. One particular feature of the Highway is that it will cut through the Vu Quang National Nature Reserve increasing the accessibility to the protected area which is adjacent with the Nakai-Nam Theun NBCA. The Ho Chi Minh highway, which is the biggest transport infrastructure construction project in Viet Nam, is planned to be finished in 2010.

Quang Binh located south of Ha Tinh is connected to Lao PDR through 2 major roads, Route No. 12 crossing into the province south of the Nakai Nam Theun NBCA, and Route No. 9, running through Savannakhet Province and continuing through Quang Binh down to the coast. The Vietnamese extension of Route 9 continues 85 km from the border to Dong Ha, presently being improved as part of the ongoing East-West Corridor GMS Project. Route No. 9 also skirts two NBCAs in Savannakhet Province (Phou Xang He and Dong Phou Vieng) where conservation and illegal wildlife trade are important issues.

Industry

The industry sector in the two provinces mainly consist of building and construction, textile, and processing industries. In the future, Ha Tinh province plans to developing heavy industries to make use of iron ore deposit, inside the province.

Two industrial zones are also planned, one of them located along national Route 8.

Forestry

The forest of Ha Tinh and Quang Binh has been extensively logged in the past and only limited areas of relatively undisturbed forest areas remains in the lower parts of the provinces. Much of the remaining forest is found in the Vu Quang Nature Reserve.

Poverty

Ha Tinh is one of the poorest provinces in Vietnam although poverty has been reduced by development programmes and poverty reduction initiatives over the last years. A Participatory Poverty Assessment (Action Aid, 1999) of 6 communes in Ha Tinh, including Son Ham Commune in the trans-border Huong Son District, found that a majority of people (75% of households) could be classified as either “poor” or “hungry” according to their own assessment. According to official poverty assessments the percentage of people in the province living under the poverty line is 46%. Quang Binh Province also ranks among the poorest provinces in Vietnam with 50% being classified as poor according to the National Human Development Report 2001.

Ethnic Minorities

The ethnic composition of Ha Tinh and Quang Binh provinces is overwhelmingly Kinh, the dominant ethnic group in Vietnam. Specific or disaggregated information on ethnic minorities and their economic and social situation is difficult to obtain for these two provinces. However, based on national surveys and studies (UNDP 2002) there is a widening poverty gap between the minorities and the majority Vietnamese. This is despite modest gains and efforts to focus on the minorities through government and donor funded development projects. Development challenges include isolation and remoteness, reduced access to good land and natural resources, low access to credit and productive assets, limited quality of social services and limited participation in government structures and public life. In addition, the process of sedentarisation of small groups like the Chut has probably also made social development very challenging.

As with small minority groups in Lao PDR, there is pressure to integrate and assimilate into the mainstream cultural, social, political and economic systems.

Conservation

The Vu Quang Nature Reserve in ha Tinh extends around 30 km along the mountainous Lao Vietnamese border and directly adjoins the north-eastern half of the Nakai Nam Theun NBCA. The Reserve covers an area of around 550 square km spanning from low elevation landscape types dominated by grassland and shrub to high montane habitats of similar quality and biodiversity as in the Nakai Nam Theun NBCA. Vu Quang Nature Reserve was decreed a nature reserve in 1986 and upgraded to national park status in 2002. Much of the reserve area was created on previous logging concession land with only the high mountainous areas consisting of relatively undisturbed forests. Between 1995 and 2000 the WWF Indochina Programme implemented the “Vu Quang Conservation Project” and prepared a management plan for the Reserve.

Vu Quang is credited with the discovery of two previously unknown large mammals, the Vu Quang ox (*Pseudoryx nghetinhensis*) or Saola, first described in

1993, and the giant muntjac deer (*Megamuntiacus vuquangensis*), discovered 2 years later. Other new species have also been found, including the world's smallest muntjac deer, the Truong Son muntjac (*Muntiacus truongsoneensis*). In addition to the mammal discoveries, 5 previously undescribed fish species have been discovered since 1992.

In general the largest threat to biodiversity in the Vu Quang nature reserve and the transborder areas is human expansion in terms of establishment of new settlements, conversion of forest land to agricultural land, logging and fragmentation of habitats, hunting and livestock grazing. Hunting and logging occurs throughout the reserve as does grazing of cattle at all times of the year. Another threat to the biodiversity is the planned development of the Ho Chi Minh Highway (National Highway NO. 2) that will cut directly through the Vu Quang Nature Reserve. This may lead to fragmentation of habitats and human settlements being established close to the most pristine parts of the reserve.

5.13.2 Thailand

The region in Thailand across from Khammouane and the NT2 influence area comprises the provinces of Mukdahan and Nakhon Phanom. This region is of significance in a cumulative perspective as future economic integration driven by infrastructure developments (the Mekong bridge at Savannakhet and a possible future one at Thakek) will stimulate economic growth on the Lao side of the border and affect developments relating to conservation, migration, human trafficking and social development in the NT2 influence area.

Nakhon Phanom and Mukdahan had a population of around 711,000 and 330,000 respectively in 1998 (JICA/CPC, 2001). The agricultural sector is the largest employer with 67 and 62 % of the population but in terms of share of the total economy it contributes less with only around 20% of the gross provincial product. The service sector is the most important in this respect with a contribution of 60 to 65% employing 22 and 28% of the labour force in Nakhon Phanom and Mukdahan respectively. The industry sector employs 10-12% of the labour force and contributes 15-19% to the provincial economies. The 2 provinces are expected to see a rapid economic growth in the future with a shift towards "higher value added" production and a doubling of the gross provincial production within 2020.

Population growth is moderate ranging from 1.1% in Mukdahan and 0.7 in Nakhon Phanom. In the future it is expected to be around 0.8%. Due to the fact that the agricultural sector has little room for expansion a stronger rural urban movement is expected in the future.

The prevalence of HIV/AIDS in the population is relatively high indicated by a prevalence infection rate in pregnant women of around 8.6%. Number of AIDS cases per 100,000 people is estimated to be around 17 (UNESCAP, 2004).

6 IMPACT ZONES

6.1 Introduction

For clarity the relevant study areas of the CIA have been combined into five “impact zones” (see Map 7). The intention is to avoid too much repetition and overlap in conclusions. It is necessary to be flexible and realistic in determining the level of detailed assessment and geographic focus and at the same time cover all the important issues. For some development trends and impacts, the administrative units (provinces and districts) will be the most relevant units for which to assess the cumulative impacts. In other cases the river and the catchment is a more important reference area. These two zoning principles have been combined to make suitable analytic and presentation units.

Broadly speaking it can be said that two zones cover most of the project area impacts, two zones cover what can be classified as downstream or impacts on the province level and one zone primarily cover international issues and impacts.

6.2 Nakai Plateau

This area covers the Nakai plateau to the west of the planned reservoir. It includes the resettlement areas, and land that will be more heavily utilised under the new land use regime.

This zone is the one covered most in detail in the project specific EIAs, Management Plans and Development Plans, initiated by the developer or funding organisations. The CIA is not supposed to repeat these analyses, but rather supplement the existing assessments with the cumulative and long-term perspective.

6.3 Nakai Nam Theun NBCA

This also covers the Nakai-Nam Theun Biodiversity Conservation Area. Impacts on the NBCA and the ethnic minorities living in that area together with those on the Vietnam side will also be commented upon.

6.4 Xe Bangfai Basin and Surrounding Districts

This zone will cover the lower part of Xe Bangfai River and the water use related activities along its reaches in Khammouane and Savannakhet. The areas in and around Thakhek, Mahaxai, the villages close to the NT2 Project sites and other areas in Khammouane and Savannakhet that might be influenced by the project will be covered under this heading.

6.5 Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts

This zone will cover the rivers and adjacent lands of Nam Theun from the planned Nakai damsite to the reservoir of Theun-Hinboun and the Nam Kading and Nam Hai/Hinboun from Theun-Hinboun down to their confluences with the Mekong. Potential impacts on the planned conservation corridor will be discussed here. In this section will also be discussed impacts on the relevant districts of Bolikhamxay.

6.6 The Mekong Basin

This section will cover all aspects related to, or dependent on, the hydrology and water use of the mainstream Mekong, from the Nam Kading discharge to the Mekong Delta in Vietnam (including the arm/tributary of Great Lake).

There are, however, some impacts that might be observed outside the Mekong Basin (i.e. districts east of the Lao PDR - Vietnam border) and there are impacts that are not primarily river related. Such impacts will also be discussed under this heading.

7 PREDICTIONS OF CUMULATIVE IMPACTS

7.1 Introduction

7.1.1 *Perspectives*

In this chapter the possible impacts predicted to be found in the different impact zones (as defined in the previous chapter), are presented. The potential impacts described are the cumulative impacts. As mentioned initially, this is the **combined impact of the NT2 Project and other projects and development trends envisaged in the 5-year and the 20-year perspective.**

It has been decided to define the base date for the scenarios to be the year for NT2 construction start, which is envisaged to be 2005. Thus the 5-years perspective will be at the time of commissioning i.e. **2010**, and the long-term horizon to be 20 years after assumed construction start, i.e. **2025**.

7.1.2 *Prediction of Trends, Impacts and Scenarios*

The CIA bases its assessment on plans for development or trends observed in the relevant sectors. A problem is that some sectors do not have specific development plans. Some sectors might have plans but there are no implementation mechanisms connected to the plans and thus the plans cannot be recognised to be realistic. Hydropower can be considered as a well-planned development sector. Even here we see that reality diverts from the original staged development plans or that the development plans are frequently revised. Other sectors are totally “out of control”. Several developments are mostly dependent on outside forces, which are impossible to predict, for instance global or regional economic development, advances in health science, etc. In this perspective the impacts of specific planned projects will be totally swamped by the large-scale developments. This is in particular the case when trying to predict the 20-year scenario.

7.1.3 *Responsibility*

It is important to realise that it is sometimes difficult to identify which part of the assumed impacts can be attributed to the NT2 Project, what are caused by other development projects, and what is a result of the general trends in economy and social development. By no means should the predicted cumulative impacts be interpreted as the potential results of the Nam Theun 2 Hydropower Project alone.

7.2 Nakai Plateau

7.2.1 *Introduction*

In the construction period and shortly afterwards the social and environmental impacts on the Plateau will be totally dominated by the impacts of the establishment of the reservoir, the resettlement and other construction and support activities. A number of fundamental changes will occur and most of the impacts can be considered as “project specific impacts”. The cumulative impacts will be minor and difficult to distinguish from the project specific impacts. In the 20-year perspective a more settled situation is assumed, where some of the project induced developments and cumulative impacts are likely to be more prominent.

In the following section some of the basic “project specific impacts” are described as background or as a perspective for the discussion of the “cumulative impacts”. It is, however, not the purpose of this report to give a comprehensive picture of the impacts of the NT2 project. For completeness and details we refer to the studies mentioned in Chapter 4.

7.2.2 *Impact Predictions*

Hydrology and Vulnerability to Flooding

The new “lake” that has replaced the Nam Theun will dominate the plateau. The lake level will be controlled by the operation of the NT2 power station and the release of water from the Nakai dam. These project impacts are described in detail in the EAMP (NTPC 2003). Neither in the short-term nor in the long-term perspective are any upstream hydropower or larger irrigation schemes planned that might influence the hydrology of this area.

Water Quality and Water Supply

The water quality in the reservoir will, as described in the EAMP (NTPC 2003), undergo changes in the years after inundation. In the first years (end of **5-year** period) the reservoir will be rich in nutrients (eutrophic) and organic materials causing alga growth in the upper layers and development of an anoxic (oxygen depleted) deep layer.

In the **5-year** perspective most of the resettlement villages and villages situated along the rim of the reservoir, including Oudomsouk, will have started to utilize the reservoir as its main water source. Water will in general be made potable by boiling, but a certain percentage of the population will probably continue to drink untreated water. Due to the high groundwater level, it will be easy to construct shallow wells and this will supplement the piped water schemes.

Potential water quality problems that might impair its uses as drinking water and for irrigation of vegetables will for the most part be linked to bacterial contamination in the streams and in shallow, closed parts of the reservoir. Contamination in terms of pesticide residues in the water will in general not be an issue due to the size of the reservoir and the limited scale of intensive agriculture.

In the **20-year** perspective the release of nutrients from the reservoir deep layers will be reduced and the lake be dominated by the less nutrient rich water from the tributaries. The reservoir will move into a more oligothrophic status. This change might be counteracted by the discharge of wastewater from the increased population on the Plateau and the increase of fertiliser intensive agriculture in resettlement areas.

An increase in tourist and recreational facilities will require further development of the water and sanitation system. This development will also enable some of the villages to link up and improve the quality of their water and sanitation systems. It is not assumed that polluting industries or other activities will develop on a scale that can jeopardise the water quality requirements for fish production or water supply.

Fisheries and Aquatic Biodiversity

At the end of the **5-year** period the reservoir will be filled up and the river ecosystems replaced by a lake ecosystem. The basis for a higher fish production is likely to have been created and the basis for new fisheries established. The

likely species composition and production potential is currently being studied as part of the NT2 Environmental Management Plan. This fisheries development will however, be in its infancy at this time as the reservoir has just been filled. The fish populations will not be properly developed and there are likely to be many physical obstacles creating difficult fishing conditions.

In the **20-year** perspective the systems will be settled, both ecologically and institutionally. This involves a conversion of a flowing (lotic) ecosystem into a static (lacustrine) system. This may negatively affect some species that require flowing water to complete their life cycles. Other species, however, will have no problem in adapting to the new “reservoir” conditions and will likely proliferate and dominate the species composition. These will include a number of small carp (Cyprinid) species and also fish belonging to the labyrinthine species group. If good stocks of fish develop significant fishery will be made possible. There might be pressure from outside fishing entrepreneurs to establish businesses. It is questionable if the SEMFOP intention to give priority to local small-scale fishing can hinder this development. Large-scale fisheries run the risks of overexploitation with reduced long term economic benefits and consequently further marginalisation of local fishermen.

Industrialised facilities for fish processing is not envisaged on the Plateau. However, simpler village based units for drying and smoking will most likely emerge and give employment opportunities for the local population.

The effect that the reservoir will have on prawns, frogs, crabs, snakes and other aquatic animals, that also form part of the diet of the Lao rural population, is uncertain. Irrigated land during the dry-season months may favour the production of “non-fish”.

Terrestrial biodiversity

The most important area for terrestrial biodiversity in the Nakai Plateau is the wildlife corridor between Nakai-Nam Theun NBCA and Phou Hin Poun NBCA.

In the **5-year** perspective, the 450 km² reservoir will have been established and destroyed the terrestrial ecosystems and the biodiversity values found here. The reservoir drawdown zone will appear as a barren boggy area. Improvement of roads, other construction activities and increased human population, will lead to a further encroachment of the ecosystems on the Nakai Plateau. Some hunting for subsistence and trade, and some illegal logging might still take place, brought about by improved access and influx of people. However, the availability of valuable products that can be harvested will have been significantly reduced except for on the outskirts areas of the plateau. In addition the implementation of the community forest plan will probably contribute to more sustainable use of the forest resources.

In the **20-year** perspective, following the improved road network, better trade opportunities and a general increase in tourism, it is likely that the Nakai plateau, with its link to the Nakai-Nam Theun NBCA, will develop into a centre for eco-tourism. The eco-tourism will generate money for the local communities, and will also be an incentive for increased protection of the natural values in the area. The village forestry programme will have helped restore some of the forest land. It will not have returned to its original tree species composition but might still be able to provide habitats for a variety of bird and mammal species. The reservoir drawdown zone will become more established with vegetation that survives periodic inundation.

Agriculture and Forestry

Agriculture and forestry will in the **5-year** perspective be dominated by resettlement activities and the efforts to establish sustainable livelihoods under the RAP. The optional livelihood models that will be offered to the resettlers will still be in the process of being adapted to individual choice and preference. Irrigated rice, vegetable production, perennial crops, agroforestry, village forestry, domestication of NTFPs and livestock will be important components in the livelihood models. Only a part of the resettlers will be able to adopt and practice irrigated rice.

The remaining forested areas on the south-western side of the plateau will have started to be utilized by the resettlers as a source of cash income. Village forestry associations will be under formation and training and the forest restoration activities will have started.

In the **20-year** perspective a range of farming systems will have been established incorporating irrigated rice and cash crops, livestock, agroforestry, village forestry and cultivation of domesticated NTFPs. A certain percentage of the households will produce rice enough for their own consumption while others will rely on sale of vegetables, livestock and NTFPs. The market for vegetables and commercial crops will have expanded beyond the Plateau and the district centre to the urban areas like Thakek and Savannakhet. The marketed crops will consist of a mix of temperate region vegetables (cabbage and carrots) and fruits. Livestock, where fodder production and stall-feeding is increasingly replacing free ranging, will constitute an important part of cash incomes for a considerable part of the resettler households.

Village forestry will be dominant on the Plateau and harvesting of timber will be predominantly done according to long-term plans. The forest will be restored to the degree that income can be provided from collection of non-timber-forest-products (NTFPs) and selective timber harvest.

Urban Development and Population Growth

In the **5-year** perspective, most of the expansion of Oudomsouk will be driven by the establishment of the workers' camps and the associated influx of camp followers. Some immigrants will possibly settle in a haphazard way, while others will settle into areas that are served by an expanded water supply and drainage/sewage system. By 2010 the population will possibly number 3,500 to 4,000 people, dependant on the level of still ongoing construction activities. This represents an increase of 84 to 110% in relation to the 2003 population figure.

In the **20-year perspective** it can be expected that the population in the Oudomsouk will develop more slowly. With a population growth around 3% incorporating natural population growth and in-migration the population will be around 5,400 by 2025. This represents an increase of more than 180% compared to number of inhabitants in 2003. However, with a stronger in-migration of people from the Nakai-Nam Theun NBCA and development of ecotourism and commercial fisheries the population may be somewhat higher.

Health

The description of the present status and possible developments of the health situation on the Plateau is covered in detail in several project specific assessment studies. It is difficult to distinguish between aspects strictly being a result of the NT2 Project and what is a result of a combination of development factors, which are the main focus of this study.

In the **5-year** perspective the NT2 Project will dominate the development picture. In addition to the project specific impacts the project will initiate new migration patterns for people in the surrounding areas, in particular from the Xe Bangfai Basin and from communities in the NBCA.

Many migrant workers will experience an improvement in the standard of nutrition compared to in their home villages. They may also be less exposed to certain communicable diseases and conditions, and will have better access to emergency and/or routine health care.

The Nakai district centre, as well as ad hoc settlements that may spring up near the campsites, may potentially become major focal points for the transmission of HIV/AIDS and other STIs. Rapidly changing socio-economic conditions and behavioural practices at these sites, amongst young men and women, increase the risk. Knowledge and understanding of the causes and means of preventing STIs is likely to remain low amongst many at risk individuals unless preventive interventions are successfully and rigorously carried out

As a result of construction activities and the influx of workers and other migrants in and around the Nakai Plateau, the frequency and severity of vehicular accidents will increase.

The Project related health programme will keep in check many of the most negative health effects.

In the **20-year** perspective Nakai district may have changed dramatically. Although the size of the district centre may have increased only moderately since construction, new developments and programmes initiated by the NT2 Project are assumed to have significantly improved the health conditions on the Plateau. Malaria cases and dengue fever may be rare events. The improvement in public water supply systems and the use of latrines will reduce the number of illness caused by water or food-borne diseases.

Changing diets and lifestyles, will have altered the picture of morbidity and mortality. Communicable diseases like tuberculosis may have become relatively less important compared to non-communicable diseases associated with chronic ailments, aging, and new behavioural patterns. Diabetes, circulatory diseases and heart ailments, cancers and psychological problems will emerge as problems. Many health workers at dispensaries and hospitals, however, may not have been re-trained to deal with these emerging health issues.

The high level of vehicular accidents is not expected to have declined. A recent study on the newly complete Route 9 in Savannakhet Province predicts an increase in vehicular accident by about 100%, based on forecasts for the first 5 months after the upgrading of the road (Benefit Monitoring Report, 2004). Although the traffic volume will be considerably less along the upgraded Route 8B and new access roads, a doubling of the number of accidents is considered a realistic estimate due to the dramatic increase in the number of vehicles of all types and sizes on the roads.

Services Capacity

In the **5-year** perspective the Nakai district services will have received considerable support in terms of staffing, training and financial resources. District services will thus be far better prepared and equipped for the task of assisting development of livelihoods and offering basic health care and other services to the resettlement population and the rest of the inhabitants in the district. However, it must

be expected that there will still be shortcomings in terms of health outreach services and hospital and health centre facilities. Education facilities in the resettlement villages will largely be in place but difficulties will be faced in connection with recruitment of qualified teachers. Agriculture and forestry extension services will have received considerable reinforcement but are likely to still be struggling to cope with the task of assisting resettlers to establish viable livelihoods.

20 years ahead, district services will have reached a sort of equilibrium considerably below the activity and capacity level that was common during the time they received specific project support. Some of the service provisions have been taken over by private providers especially in the health sector. In general service capacity and provision are likely to be below the demands from a growing population.

Ethnic Minorities

Except for the new arrivals in Oudomsouk town, the newly established district capital of Nakai, almost all of the inhabitants on the Nakai Plateau are ethnic minorities as defined in the EMDP (Dec 2003). However, there is a clear trend towards integration and assimilation of the groups on the Plateau into mainstream Lao culture. With the arrival of educated and more resourceful lowland Lao during the construction period (**5-year** perspective) and the already noticeable increase of majority groups in the district capital, the ratio of ethnic minorities in relation to lowland Lao and related groups is likely to change. At present the ratio is approximately 1:5 in favour of the minorities with the lowland groups mostly located in the district capital and in small numbers along the existing roads. It is likely that this ratio will have changed to 1:3 due to influx of outsiders. Due to the changes outlined in the proposed livelihood systems, education improvements (in the Lao language), newly established Buddhist monasteries and the existing mix of culture, the so-called 'melting pot of the Plateau', a local Lao culture will develop consisting of Lao language and cultural characteristics. The project is likely to further hasten this process of integration.

In the **20-year** perspective the communities on the Nakai Plateau will likely be fully integrated into the mainstream Lao culture and nation state. This implies that the Nakai culture will be a Lao culture (Buddhism, Lao language and Lao government institutions) without many of the common characteristics of Ethnic Minorities, such as reliance on natural resources, unique cultural traits, languages and institutions. Inter-marriage between groups is likely to increase and present ethnic identities (Bo, Brou, Sek and Vietic) are likely to be further blurred or even forgotten. It is also likely that people will start to define themselves as *Lao Loum* (lowlanders or dominant group) or as Tai Nakai (Tai-Lao group of the Nakai region) as is already the trend among some residents of Nakai.

Poverty Alleviation

There should be considerable improvement on the Nakai Plateau with regard to the levels of poverty. Given the fact that the resettlers were recorded as being below the Lao poverty level in terms of annual household income of less than 700 USD (462-449 USD), serious rice deficiency, unstable livestock populations and dwindling natural resources as well as very limited social services (EMDP 2003), it is expected that in the **5-year** perspective the rural population of the Nakai Plateau will experience a considerable improvement in the living standards. This can be summarised as:

- Increased food security (but still reliant on rice supplements)

- Improved health and education services
- Improved market access for vegetables and other agricultural products
- Improved transportation, communications (market access) and electricity
- Training programmes (community forestry management) and skills development support (agricultural extension)
- Employment for some during the construction period

In many large infrastructure developments, it is common that more resourceful and educated groups can more easily benefit from socio-economic change and rapid integration into market-oriented economies. In the **5-year** perspective social disparity may increase due to the differences in economic resources (livestock), available labour, education levels and degree of social support and network. There are, however, measures to deal with disadvantaged and vulnerable households in the RAP since it is acknowledged that household's adaptation to the new livelihood systems will vary in terms of economic performance. Existing differences will manifest themselves over time and the fact that these communities will become fully integrated into the mainstream economy could exaggerate social disparity to some extent. However, it should be noted that there should be a significant overall decrease in the incidence of poverty.

The expected growth of the service sector and government jobs in Nakai District town (Oudomsouk) will concentrate capital in this town, creating an economic gap between the rural communities and new urban development. It is expected that most of the government positions and service sector will be dominated by lowland Lao outsiders with more education and financial resources to develop businesses. This process has already started and is likely to accelerate during construction.

Gender relations are likely to change due to increased urbanisation, the influence of lowland values and differences in livelihood systems. In rural communities, there was a division of labour but most tasks were shared, with women and men partaking in making of goods and the production of food. However, men dominated formal decision-making, politics and working outside the village. In the **5-year** perspective, it is expected that men will benefit more directly from development initiatives since it is likely more men will work as wage labourers. However, women should also benefit from aspects of the livelihood model since they are often responsible for buying and selling at local markets. Improved services, water supply and other planned improvements are likely to save women considerable time in the domestic sphere, allowing more time for income-generating activities. In the urban setting of Nakai, modern, lowland Lao values are likely to become the norm, and this might lead to increased male dominance since men are likely to become the main or only contributor to the household economy, decreasing the influence women have on decision-making.

In the **20-year** perspective, it is likely that social disparity between household within communities, between villages and urban areas (Nakai town) and between men and women will increase unless direct interventions are introduced to counter these trends, such as specific programmes directed towards rural areas, gender empowerment measures, quotas or positive discrimination. The performance of the education systems and the quality of education at the primary level and general economic development will determine to a large extent how social disparity develops. It is expected that the Nakai Plateau, in general, will not have a 'significant' poverty gap due to the expected improvements in the RAP.

7.2.3 Summary of Impacts

Table 24: Summary of the most Important Cumulative Impacts on the Nakai Plateau

Nakai Plateau	
5-year scenario	20-year scenario
<p>The impacts will be dominated by NT2 project activities. Some additional impacts are however, envisaged due to improved access and activities "following" the construction work and temporary population increase.</p> <p>The most important impacts will be increased pressure on wildlife, increased risk for STIs including HIV/AIDS and increasing frequency and severity of vehicular accidents.</p>	<p>The situation will have stabilised but will have changed significantly compared to the initial situation. Communication both north and south will be radically improved and the reservoir will have attracted new activities like commercial fisheries and tourism. It is assumed that:</p> <ul style="list-style-type: none"> • Sanitation and water supply will be improved. • The Odomsouk population will possibly have increased with more than 180% in relation to number of inhabitants before the start of construction activities. • Commercial fisheries will be established. • The health conditions will be improved with reduced incidence of malaria and food and water borne diseases, and there will be a shift from communicable towards non-communicable diseases. • Health and education services will be struggling to keep up with demand due to population increase. • There will be increased employment in service sector including tourism. • There will be increased cultural integration on the Plateau with blurring of ethnic borders and loss of identity.

7.3 Nakai-Nam Theun NBCA

7.3.1 Introduction

The Nakai-Nam Theun NBCA can be considered as part of the NT2 project area. The planned reservoir forms a part of the NBCAs western border. Nakai-Nam Theun NBCA is ranked as the most important NBCA in the whole of Lao PDR (Robichaud et al. 2001), and is probably one of the most important protected areas in the whole of Southeast Asia. The protection of the biodiversity values of NBCA has been the focus of earlier studies, in particular the Social and Environment Management Framework and Operation Plan (SEMFOP), which specifies a programme for sustainable management.

7.3.2 Impact Predictions

Hydrology, Water Quality and Water Supply

The only potential changes in hydrology and water quality of the rivers inside the NBCA might be caused by increased deforestation and expansion of the practise of swidden agriculture. This potential development might lead to increased sediment content in the rivers. Such development is supposed to be efficiently counteracted by the SEMFOP initiative.

For people living close to the reservoir the water supply situation will be improved both in the **5-year** and in the **20-year** perspective.

Fisheries and aquatic biodiversity

The NT2 project will not have any direct impact on the rivers and streams in the NBCA. The potential impacts will be caused by downstream changes. It is not foreseen that that other projects and developments will have an impact on the fisheries and aquatic biodiversity in the NBCA.

In the **5-year** perspective the important change will be the establishment of the reservoir and the Nakai dam. It is likely that this will have an impact on the up-stream migration of fish from Nam Theun to the tributaries in the NBCA. In the first years after commissioning of NT2 the downstream fish populations will be in a pioneer stage, establishing new production patterns which are difficult to predict.

In the **20-year** perspective the ecological situation will be more settled. However, still the impact on upstream fish biodiversity and fisheries opportunities are uncertain. Much will depend on whether the reservoir fish population becomes dominated by small pelagic species confined to the reservoir or by larger species using the tributaries in the NBCA for breeding.

Terrestrial biodiversity

In the **5-year** perspective, the commencement of operation of the NT2 Project will provide the environmental authorities with annual funds of US\$ 1 million for management and protection of the Nakai-Nam Theun NBCA. The SEMFOP initiative will provide a unique opportunity for development of sustainable management practices and better protection of terrestrial biodiversity in the area. The Nakai-Nam Theun NBCA will end up having a more advanced control and management system than any other Lao PDR NBCA. Thus, both in the **5-year** and in the **20-year** perspective the situation for primary forests and the unique fauna inside the NBCA will be better than without the project.

The most serious threat to the biodiversity values of the NBCA comes from planned development in Vietnam. The Ho Chi Ming Highway (National Highway No.2) will run along the border opening up previously relatively inaccessible areas for settlement and economic exploitation. It will cut through the Vu Quang National Nature Reserve and also significantly increase the access to Nakai-Nam Theun NBCA. The impact will be felt in the **5-year** perspective and, due to the assumed new settlements “following” the road, further intensified in the **20-year** perspective.

In the **20-year** perspective some eco-tourism might be developed in the NBCA. The disturbance to terrestrial biodiversity will increase marginally, but on the positive side it means increased opportunities for the local people to generate money and improve their livelihoods from sustainable activities.

Agriculture and Forestry

Both in the **5-year** and in the **20-year** perspective the development will be controlled by the SEMFOP programme. The pressure on forest and land resources in the NBCA is also likely to decrease due to migration of people from the NBCA to the Plateau. The main potential threat to the principle of sustainable use of forest resources and sustainable agricultural practises will be influx of people and illegal logging originating from the Vietnam side of the border.

Urban Development and Population Growth

From communities in the NBCA some, mostly younger people, may move to the Plateau in search of employment during the construction period. For those who cannot successfully find employment there, some may seek work further afield; in one of the nearby district towns, or in the establishments related to the development in the Savannakhet Economic Zone or East-West Corridor, or in Thailand. Also people from the resettlement villages might participate in such out-migration triggered by the activities and improved transportation opportunities between the Plateau and the surrounding areas. It is not predicted that this will occur on a significant scale

Both in the **5-year** and in the **20-year** perspective it is estimated that the natural population growth rates, which are presently above the average for the country (3.79-6.25% recorded in the EMDP for the SEMFOP), will be offset by out-migration. Thus, it is predicted that out-migration to the Plateau for work and in search of better services and markets may lead to population growth rates for the NBCA of about only 2-3%. Large-scale out-migration is not envisaged due to attachment to traditional territories, relative abundance of resources and initiatives under the SEMFOP to improve existing agricultural practices.

Health and Education

Health and education facilities in the NBCA are lacking for the most part. Reliance on traditional medical practices and irregular visits from health workers characterise the situation. There are few properly functioning schools, a serious shortage of teachers and high level of illiteracy. In the **5-year** perspective, the health and education interventions outlined in the SEMFOP will be fundamental in supporting a weak government system in this remote area. It is predicted that there will be some improvements by 2010, including more regular visits by trained personnel, improved availability of medicines and possible reduction of malaria and nutritional problems. It is also expected that some of the existing schools may be restored or improved, better equipment made available and the presence of teachers more regular. In the **20-year** perspective, further improvements are envisaged, including immunisation coverage, improved hygiene and nutrition, established health centres and functioning village schools. However, the standards of health and education services will not be the same as on the Nakai Plateau and this may be one of the attractions for out-migration.

Ethnic Minorities

In the **5-year** perspective the situation for the ethnic minorities of the NBCA will differ from the Nakai Plateau since these groups are less integrated and will not experience directly the influx of lowland culture. However, many groups may attempt to find work, to increase economic interaction and even to relocate to the Plateau during the construction period. This is likely to lead to some integration but not to the same extent as with the Plateau communities. The livelihood development schemes outlined in the SEMFOP may act to slow down this process and counter to some extent the temptation to migrate to the Plateau.

For the **20-year** perspective there will be increased contact with the Nakai Plateau, both economically and culturally, the relative isolation of the various ethnic minorities in the NBCA will no longer be a reality, at least not to the same extent as before. Government institutions and services will expose groups to lowland cultural traditions. It is likely that many households may choose to leave this area for the better standards of the Nakai Plateau. Most ethnic minorities have relations to those residing on the Plateau. It is likely that the natural population in-

crease in the NBCA will result in considerable out-migration. Labour migration, both seasonal and to urban areas for longer periods, may become common among some groups. Those remaining will integrate culturally with Lao replacing many of the ethnic languages and local beliefs being modified by Lao customs, traditions and Buddhism. Small Vietic groups are unlikely to retain their ethnic identities and will probably be integrated into larger ethnic groups like the Brou or adopt Lao identities.

Poverty Alleviation

Some improvement is anticipated in terms of poverty alleviation for the NBCA during the **5-year** perspective but significant development will require more time, given the participatory approach to be taken in planning, implementation and monitoring and the logistical challenges presented. In the **20-year** perspective, these improvements should be moderate to significant, given the fact that the rates of poverty are higher in this region and interventions are likely to have a positive impact. These can be summed up as:

- Increased food security (development of paddy and improved swidden cultivation techniques).
- Improved health and education services locally and better access to hospitals and secondary schools in Nakai town.
- Improved market access by boat to Nakai town markets.
- Training programmes, skills development, agricultural extension and possible sources of employment in conservation and tourism.

7.3.3 Summary of Impacts

Table 25: Summary of the most Important Cumulative Impacts in Nakai-Nam Theun NBCA

Nakai-Nam Theun NBCA	
5-year scenario	20-year scenario
<ul style="list-style-type: none"> • Migration of fish from the Nam Theun affected by the establishment of the reservoir. • Better protection of biodiversity and forest resources through SEMFOP while at the same time threats to biodiversity will come from extractive activities and hunting linked to developments on the Vietnamese side of the border including road building and increased population. • Improved social service delivery in terms of availability of medicines, possible reductions of malaria and nutritional problems, improved access to education. • Some integration of ethnic minorities and adoption of elements from dominant lowland Lao culture but not to the same extent as with the Plateau communities. • Some improvement in terms of poverty alleviation. 	<ul style="list-style-type: none"> • Effect on fish biodiversity and production will depend on whether the development of reservoir fish population become dominated by small pelagic species confined to the reservoir or by larger species using the tributaries in the NBCA for breeding. • Increased threat to biodiversity through population increases on the Vietnamese side of the border leading to increased exploitation of the NBCA. • Further improvements in social services including immunisation coverage, hygiene and nutrition, health centres and functioning village schools. • Natural population increase will result in considerable out-migration and labour migration to urban areas for shorter or longer periods. • The process of integration with the lowland Lao culture will have proceeded further and led to assimilation of small Vietic groups. • Significant reduction of poverty in terms of food security, better market access and employment opportunities.

7.4 Xe Bangfai Basin and Surrounding Districts

7.4.1 Introduction

In this zone the impacts from the NT2 Project can in broad terms be divided in two types:

- Impacts generated by the construction activities, which will be most prominent in the middle part of the basin in the Gnommalath and Mahaxai districts. In particular Gnommalath, where large construction works will take place and labour camps be established, will experience many of the same impacts as found the Nakai plateau.
- Impacts related to the hydrological changes caused by the transfer of water from the Nam Theun Basin into the Xe Bangfai. This impact will create a new and permanent change in water flow regime and will be felt all the way down to the confluence with Mekong.

Compared to the Nakai plateau zone the assumed cumulative impacts in the Xe Bangfai Basin will to a much larger degree be influenced by development in other sectors than hydropower.

7.4.2 *Impact Predictions*

Hydrology and Vulnerability to Flooding

In terms of hydrology, the main impact in Xe Bangfai is the discharge from NT2 just upstream Mahaxai. No further development of hydropower is expected in the **5-year** or **20 year** perspective that will affect Xe Bangfai, with the exception of the Lower Xe Bangfai, which is subject to backwater from Mekong and will thus be impacted by future changes in water flow in the mainstream Mekong. The plans for irrigation developments in the Gnommalath district and in the lower Xe Bangfai are not supposed to result in significant changes in water flow in the river in the **5-year** or in the **20-year** perspective.

In the pre-NT2 baseline situation, the mean discharge in Xe Bangfai at Mahaxai varies from a minimum of 12 m³/s in March/April to a maximum of almost 800 m³/s in August. In extreme years, however, the annual maximum can vary from 270 to 1900 m³/s, as a monthly average. Furthermore, the instantaneous discharges may be much higher than the quoted monthly averages.

In the pre-NT2 baseline situation, the mean discharge in Xe Bangfai at Mahaxai varies from a minimum of 12 m³/s in March/April to a maximum of almost 800 m³/s in August. In extreme years, however, the annual maximum can vary from 270 to 1900 m³/s, as a monthly average. Furthermore, the instantaneous discharges may be much higher than the quoted monthly averages.

At the time of the present study, information was not available about power agreements, which will stipulate the NT2 power production. Hence the exact magnitude of the NT2 diversion was not finally determined. It is however determined that full turbine capacity (330 m³/s) will be run 16 hours a day, while the operation for the remaining 8 hours may be from 0 to 100 % capacity. One day a week, Sunday, there will be no diversion. Thus, the average diversion will be between $6/7 \times (16 \times 330 + 8 \times 0) / 24 = 190 \text{ m}^3/\text{s}$ and $6/7 \times (330) = 280 \text{ m}^3/\text{s}$. It is these two alternatives, that will be considered in the following, while the real situation can be expected to be somewhere in between.

As monthly averages, the diversion will have a constant magnitude throughout most of the year, although in the case $Q=280 \text{ m}^3/\text{s}$, the diversion will decrease at the end of the dry season, because the reservoir is reaching the bottom. The largest *relative* diversion will occur in March (relative to the XBF flow), because the natural flow in Xe Bangfai is very small at that time. On the average, the flow in Xe Bangfai at Mahaxai will become 12-15 times larger in March than pre-NT2 flow.

During the flood period, the diversion will amount to a smaller proportion of the discharge in the Xe Bangfai. In August, NT2 increases the flow by 24-35 % in an average year.

Impacts from NT2 on flood risks in the Lower Xe Bangfai is an issue for the ongoing study by SMEC, which is planned to be submitted by July 2004. The hydraulic dynamics of the lower and middle Xe Bangfai is very complex, partly due to significant backwater effects from Mekong, partly because of a complex system of floodplain/paddies and numerous tributaries with small flood control structures (gates, etc). Without the results of that study, it is extremely difficult to assess the flood impact in the Lower Xe Bangfai in a situation with high water levels in Xe Bangfai and Mekong.

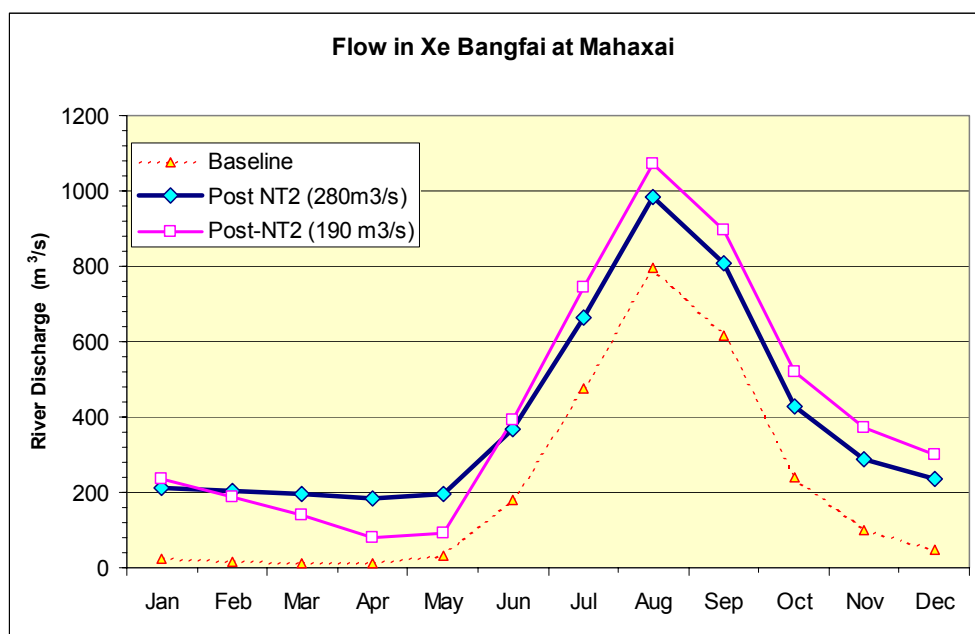


Figure 1: Annual Variation in Monthly Mean Flow in Xe Bangfai Pre- and Post-NT2 (two options for NT2 power production).

In situations with more moderate water levels, i.e. when Xe Bangfai remains within its banks, the impact of NT2 on water levels in the middle Xe Bangfai (Mahaxai) can be assessed approximately. Based on the Mahaxai rating curve (MRC Yearbook), the average NT2 diversion in March (when the relative change is largest), will induce a *water level increase of 3.4 m*.

During the flood season of an average year, NT2 will increase the natural flow from 800 m³/s to 1080 m³/s. The corresponding *water level increase is 1.3 m*. The bankfull discharge is found at 2200-2300 m³/s.

If no special flood-protection measures are taken, an addition of 280 m³/s to flood discharges will change the flood frequency regime so that for example a natural 5-year flood (2490 m³/s) will become a 2 year flood, i.e. the same flood level will occur on average every 2 years instead of every 5 years. In the project specifications it is prescribed that the NT2 diversion will stop when Xe Bangfai approaches bankfull stage.

In the lower Xe Bangfai (downstream Bridge 13), the hydraulic conditions are greatly influenced by backwater from the Mekong, and consequently also the flooding vulnerability. It has therefore been claimed that the increased risk to flooding in Xe Bangfai in general will be counterbalanced by a corresponding discharge reduction in the Mekong, and thus consequently a reduced backwater into Xe Bangfai.

Calculations done by the developer estimate the energy saving potential in connection with pump irrigation for different water levels. A raised dry season water level of around 1 m will lead to a reduction in average electricity consumption by 11% while 2 m will give an average power saving of 16%. These figure represent

averages for different pumping systems (pontoon and fixed bank installations) with a static head varying from 13 to 20 m.

Water Quality and Water Supply

The most important water quality issues identified in the NT2 impact assessments are the problem of low oxygen content in the power plant discharge water. Some local erosion by slumping of riverbanks in Xe Bangfai due to the increased flow is also envisaged. However, the riverbanks are expected to adjust to the higher flow (and rate of change) and stabilise after some years.

In the **5-year** perspective these issues might cause some problems to the use of the water for water supply. It is assumed that the labour camps will not increase the discharge of untreated wastewater as proper treatment is supposed to be in place. However, the wastewater discharges caused by the uncontrolled influx of camp followers and the general population increase in Gnommalath and Mahaxai, caused by developments along the East West Corridor, might add significant volumes of wastewater to the rivers. This might add to the problems of oxygen depletion. In addition there will be increased microbiological contamination. This microbiological contamination of the recipient will be counteracted by much higher water flow and recipient capacity in the low season. So the total picture of the water meeting microbiological standards for drinking purposes will not be much reduced. In the downstream town of Nongbok safe drinking water will be provided by a water supply system by that time.

In the **20-year** perspective the problem of oxygen depletion of the discharged water will have been reduced, as most of the organic materials in the reservoir will be digested. The wastewater volumes from Mahaxai and Gnommalath will have increased substantially as a result of the population increase and potential industrial development in the area. It is assumed however, that organised water supply, sewage collection and wastewater treatment has been established by that time, and thus that negative health impacts are not likely to occur. In addition the increased flow induced by NT2 will be beneficial as it increases the recipient capacity of the river.

The agriculture development and more intensive production methods, in particular in the lower part of Xe Bangfai Basin, will have led to increased use of fertilisers and pesticides. This will most likely lead to local problems with eutrophication and heightened levels of pesticides in drainage water and fish. This might cause problems for local surface water sources and shallow wells.

Fisheries and Aquatic Biodiversity

The impacts on fisheries in the middle and lower Xe Bangfai will be dominated by the direct impacts caused by the NT2 hydropower project. Other developments causing significant changes in water flow are not envisaged in the 5-year and 20-year perspective. The only developments that might contribute to cumulative impacts on fish production and aquatic biodiversity are increased pollution from agriculture, industry and urban areas. In addition population increase and demand for food might increase the price of fish and consequently induce over-fishing.

At this stage the predictions on changes in fish stocks and fisheries are difficult to give. Too little is known about the present situation in the fisheries, fish biodiversity and on the detailed hydrological changes caused by NT2 in the lower Xe Bangfai. These issues are presently under investigation and will be reported in separate studies. The most important question is how the migration of different

fish species will be influenced by the hydrological changes, and how the increased dry season flow will change upstream spawning habitats. Many species of fish rely on the annual production of filamentous algae that develop on hard and soft substrates during the dry-season months, when light can penetrate the relatively clear, shallow waters. This provides the “food fuel” for the fish to build up reproductive products (eggs and sperm), and also provides the necessary energy to enable fish to undertake migrations.

In the **5-year** perspective the NT2 project will have just started operation. In the first years significant erosion and turbidity problems along the length of the river are foreseen. In the initial stage also the oxygen content of Xe Bangfai might also be reduced for some distance downstream the point where the channel discharges into Xe Bangfai. These factors combined with the rise in water level will reduce the algae growth and bottom fauna in the river and consequently a reduction in fish production is likely to occur. Spawning grounds for some species might also be negatively impacted. Some traditional fishing gear will become useless, as it will not be able to be used in the new high flow situation.

In the **20-year** perspective the water quality situation caused by NT2 will stabilise. The basic assumption is that biodiversity and the production of many species might be reduced. The algae growth and thus the food supply for many fish species will still be reduced compared with the natural condition but probably more important the increased dry season flow in Xe Bangfai is likely to cause migratory disorientation. Initially, this may appear to be a positive impact, because more fish may be caught out-of-season, but in the long term it is likely to result in reduced fish production. This is based on the fact that most Mekong species are adapted to, and react to, specific flow situations for their migration and spawning cycles.

The increased flow and the assumed expansion of dry season irrigation in the basin might, however, increase the capacity for flood plain and “back swamps” fish production.

It is not foreseen that larger scale aquaculture will have developed to compensate for the loss of river fisheries.

Terrestrial Biodiversity

The areas of particular concern from a terrestrial biodiversity point of view are the upper parts of the Xe Bangfai catchment (Hin Nam No NBCA), the area west of the Nakai Plateau (Phou Hin Poun NBCA). Phou Hin Poun to a large extent belongs to the Nam Hinboun catchment. The lower part of Xe Bangfai catchment is of little interest from a biodiversity point of view as most of the land is converted into agriculture.

In the **5-year** perspective, there will be additional pressure on the natural resources and biodiversity caused by the combination of influx of people for the NT2 Project and improved road conditions locally and to Vietnam. In the Nakai-Nam Theun NBCA this pressure might be efficiently counteracted by the improved management and control systems established. The other NBCAs, however, will not have the same protection and control of illegal activities. There is therefore a risk that increased protection of NNT NBCA will change the pattern of illegal logging and hunting, from NNT NBCA to other, less controlled areas. Of special concern is the development in Phou Hin Poun NBCA where a road is under construction from Gnommalath into the protected area. It is facilitating eco-

tourism development, but it might also unintentionally open up the area for logging and uncontrolled activities.

In the **20-year** perspective, the pressure on terrestrial biodiversity will continue to increase due to a general population growth and an increased movement of people and goods through the transport corridors (mainly route no. 9). The possible construction of a cement factory in Mahaxai, less than 10 km from Phou Hin Poun NBCA, will affect the local environment due to emissions of dust and gas, but is not likely to represent a major problem to the Phou Hin Poun NBCA itself.

However, it is assumed that political recognition of environmental values has increased in this period, and that legal and institutional system for control and management of the protected areas will have been improved. If not, habitat destruction and illegal hunting will most certainly have taken its toll on the biodiversity and NBCAs in this region.

Agriculture and Forestry

In the **5-year** perspective agriculture in Gnommalath and Mahaxai districts will be more geared towards producing for the growing local and outside market. The World Bank financed rural livelihood development project focusing on Gnommalath, Mahaxai and Xe Bangfai districts will have supported this shift towards commercialisation. The improved road connections to Thakhek and Vietnam will have expanded the markets for agricultural produce, a factor that adds to the market demand created by the NT2 Project. Together with the increased commercialisation of agriculture, an intensification of the production technology will take place leading to an agricultural production based more on purchased inputs such as chemical fertilizers and pesticides. There will be a considerable increase in the number of 2-wheel tractors that are used to carry products to the local market places. However, only some of the farmers may have chosen to utilize the opportunities for cash crop production and a majority will probably still depend on rain-fed and irrigated rice for household consumption, and sale of production surpluses to generate cash. Local demand and the improved access to wider markets may have raised the farm-gate price of rice to some degree.

The irrigated area will probably to some degree be expanded but the potential offered by the NT2 for the additional water for irrigation development on the Gnommalath Plain and further downstream will not have been fully realised yet.

In the middle and lower Xe Bangfai some of the potential areas for irrigation will have been developed while plans for upgrading and rehabilitation of existing schemes may have been developed by the provincial irrigation departments of Khammouan and Savannakhet. The World Bank funded Agriculture Development Project will have finished the construction of 3 new irrigation schemes comprising 460 ha in Gnommalath and 2 schemes in Thakek District with a total of 250 ha. Both government and external funding for rehabilitation of old schemes and additional irrigation development in the area will have been secured to a certain degree. The higher water levels in the Xe Bangfai during the dry season may have led to some limited energy savings in connection with pump irrigation.

In the forestry sector the supply needs of the existing wood processing industry will have put the existing production forest areas in Khammouane Province of approximately 120,000 ha under increased pressure. The forest resources in the Phou Hin Phoun will also have come under pressure. In areas degraded by commercial logging, the local population will probably carry out non-mechanised logging on a smaller scale. However, the SUFORD Project will have started to

make an impact on local logging practices in the 2 production forest areas where villagers will be starting to adopt more sustainable timber harvesting and management practices. Commercial forest plantation areas with involvement of villagers will also have started to expand.

In the **20 year** perspective agriculture will have been further commercialised with production of crops for an expanded market. The range of cultivated crops will have been diversified and different types of fruits crops will have complemented vegetables as cash crops. The local markets for agricultural products will be Thakhek and Nongbok, which will have seen a substantial growth in their populations. However, the neighbouring areas in Vietnam and Thailand plus more remote domestic markets such as Savannakhet and Vientiane should also be developing. In spite of the development of cash cropping, production of rain-fed and irrigated rice will still be the main agricultural activity in this zone providing the mainstay for the majority of the farmers.

It must be expected that much of the potential area for irrigation will have been developed through the assistance of external funding while many of the existing irrigation schemes will have been rehabilitated and upgraded. Perhaps an estimated half of the dry and wet season potential for expanding irrigation perhaps will have been developed. This amounts to around 7,000 and 5,000 ha for the wet and the dry season area respectively. Irrigated dry season cropping will also have diversified to include crops like maize, soybeans, groundnuts and a number of vegetables crops.

Village forestry is likely to be the dominating utilization and management system within the designated production forest areas. At the same time forest plantation for industrial purposes will have expanded and become an important part of the total forest output in the zone.

Urban Development and Population Growth

In the **5-year** perspective Gnommalath will experience a sharp rise in population caused by the NT2 Project while Mahaxai will grow mainly because of the construction and operation of the planned cement factory located in the district. In addition they will also experience the impacts of being located on Route 12 and 8B. The urban areas will probably expand rapidly and only partly in a planned and orderly manner as the district plans for expanded settlements are unlikely to be implemented fully. For both these urban areas at least a doubling of the population is likely. This would bring the number of urban residents up to 4,000 both in Gnommalath and Mahaxai by 2010.

Thakhek will have its own momentum of growth, which the trade and local economic growth generated by the NT2 Project will be contributing to, offsetting partly or fully the effect of the declining timber industry. With a continued high growth rate of 3.5% Thakhek's urban population will reach around 48,000 in 2010. This represents an increase of 46%. Thakhek already has an Urban Development Administrative Authority (UDDA) that will continue to provide services and address the problems of rapid urbanisation.

Water supply, sanitation and garbage collection services will most likely be poorly developed. Individual households are likely to rely on pumping or fetching water from the nearby streams and rivers, or on shallow wells which will necessitate boiling of the drinking water. Each household will, to a certain extent, have built their own latrine or own septic tank. However, water pollution may also arise from

sewage water from toilets and kitchens being released directly into nearby rivers and streams, and from surface runoff from the urban area itself.

In the **20-year** perspective the district centres of Mahaxai and Gnommalath may continue to experience a substantial growth. A growth rate of 3%, which appears to be likely in the future, will bring their urban populations up to more than 6,000 by 2025. This represents a more than 200% increase over the present population size. It can be expected that by that time wastewater treatment, water supply and waste collection services have to some degree been established.

Thakhek will, with a continued growth rate of 3.5%, have reached a population of around 80,000 by 2025. This represents a growth of 142%.

Health

In the **5-year** perspective the health impacts will be related to the change in water flow and water quality caused by the start of NT2 operations, and to traffic accidents and increased exposure to HIV/AIDS and other STIs caused by NT2 activities and a number of other developments going on in the area.

The expected increase in sediments in the river water and the low oxygen content in the discharge water may reduce the quality of potable water used for drinking, bathing, and other household purposes, causing gastro-intestinal illnesses as well as skin problems. The changes in water levels, in and around riparian communities, may influence the prevalence and incidence of rodent and vector-borne diseases. This concern is most relevant for dengue. The promotion of an additional dry season rice crop, aided by planned irrigation schemes, might also help dengue fever to proliferate.

Gnommalath and Mahaxai lie not far from the junction of Route 8B and Route 12 that will have been improved by the NT2 Project. This will put the district centre within two hours travelling time of both the Thai and the Vietnamese border, linking it to cross border trade as well as possible international trafficking activities.

The cement factory complex near Mahaxai might at this stage have become a major local environmental health and traffic safety issue. The main problems will be dust from the processing and increased transport of limestone and products.

Increased traffic, population increase and crowded living conditions may lead to a number of health impacts. Vehicular accidents may increase substantially, there may be an introduction or re-introduction of potentially dangerous vector-borne diseases, and finally, a serious STI and HIV/AIDS situation may develop propelled by an increase in commercial sex services, increased migration, mobility and risk behavioural practices.

The Public Health Action Plan that will be implemented in connection with the NT2 Project will address these issues through a number of targeted measures, helping to prevent and limit the foreseen negative health aspects.

In addition, there are plans to build a new spacious district hospital just outside the Gnommalath district centre. This facility will serve as an inter-district facility, supporting the health care delivery network in both Nakai and Mahaxai districts. This development will have obvious positive health implications for the NT2 Project intervention area.

In the **20-year** perspective some of the health problems that were witnessed during the early years after the completion of the hydropower project, will no longer be significant. The assumed problems related to drinking water quality caused by sediment load and oxygen depletion will have decreased. After some years of operation the situation will return to normal due to natural processes and stabilisation. The assumed general economic development in the region will lead to better sanitation, health services and improved awareness in health issues. Water-borne illnesses and intestinal parasitic infestations are likely to have practically disappeared. Malaria might no longer be a problem in this region and although dengue fever might continue to break out some years, the mortality will go down.

STIs and HIV/AIDS will most likely still remain a problem particularly in the larger towns and district centres but it is assumed that better treatment may have been found and a number of private clinics and pharmacies that specialize in syndromic treatment and counselling services will have been established. However, the incidence of HIV/AIDS and STIs will remain high, due to the large number of transients passing through Gnommalath and Mahaxai. Vehicular accidents and deaths due to increased traffic will increase and will maybe become the leading cause of morbidity and mortality.

In Mahaxai District dust pollution, from transport and cement production might be a major health concern, causing increased number of respiratory illnesses

The middle and lower Xe Bangfai area will remain an agricultural production area for domestic markets in the nearby provincial centres. It is likely that local farmers will substantially increase their use of pesticides and herbicides to stimulate food production. In the end this might jeopardise the marketing of the products. The users will be at the highest risk and “unexplained” mortalities from kidney and liver failures in farming communities might be seen.

Services Capacity

5 years into the NT2 construction phase the capacity of key district service including agriculture education and health will have been strengthened through training and staffing increases in connection with implementation of the Social Development Plan and the Resettlement Action Plan. Nakai and Gnomalath are the districts that will benefit the most from this support due the fact that Nakai is the focus area for resettlement activities and that project installations are located in Gnommalath district. However, staff and capacity increases in Nakai and Gnommalath may come at the cost of less available staff in surrounding districts and beyond, created by transfers and secondments to meet the demands at Nakai.

In the **20 year** perspective the capacity of district services will in general increase in parallel with the growing economic capability of the districts brought about by local economic growth and increased tax incomes. In Gnommalath the population will enjoy better health and education services due to the inter-district hospital establishment and the permanent presence of a considerable number of staff attached to the hydropower plant that will bring extra resources to the district.

Ethnic Minorities

The SDP identifies a number of ethnic minorities in the Xe Bangfai area. These minorities, unlike those on the Nakai Plateau, share a common livelihood system with the Lao, Phou Thay and other *Lao Loum* groups in this area. There are

some differences in terms of cultural practices and degree of urbanisation, but in terms of socio-economic status the Brou or Makong of the Nam Phit and Xe Bangfai, as well as other Kautic (Mon-Khmer) groups in adjacent districts, are similar in terms of socio-economic development. Given the fact that all groups should benefit from potential development of irrigation, improved infrastructure and services, it is likely that economic integration will not be at the price of social and cultural assimilation in the **5-year** perspective. Most Brou and other minorities will remain bilingual and retain local traditions to a large extent in rural areas.

In the **20-year** perspective, the ethnic minorities in the downstream districts are likely to retain their identity to some extent in rural areas although a gradual integration into the mainstream economy and culture will occur. This is due to the fact that there are large clusters of Brou in Gnommalath and Mahaxai Districts unlike the mix of ethnic groups on the Plateau and small isolated groups in the NBCA. Lowland Lao will dominate towns and urban areas and minority households residing at these locations will probably lose their identities and merge with the local Lao groups to some extent. Buddhism may replace or subsume many of the non-Buddhist or animist traditions in the area, a process that has been ongoing for at least a century. Since virtually all education, official interaction and business is in Lao, the Brou language will remain predominant only in the domestic setting and in villages where the Brou are a majority.

Poverty Alleviation

There should be considerable improvement in the Districts of the downstream areas with regard to the levels of poverty. Average household incomes recorded in the EMDP (2003) were 664 USD, varying from 842 to 508 USD. This means that the majority of households are below the Lao poverty level of 700 USD and suffer from rice deficiency and insufficient sources of income (livestock, wages, etc.). Social services are better than on the Plateau but mortality rates and the quality of services are far from adequate. It is predicted that in the **5-year** perspective the rural population of this region will experience a moderate improvement in standards of living, primarily due to project activities. This can be summarised as:

- Increased food security (improved irrigation systems and expansion).
- Improved health and education services (Regional Health Plan).
- Increased demand for agricultural products, livestock and wage labour.
- Improved transportation (road upgrading), communications and electricity supplies.
- Training programmes and skills development support.
- Employment for some during the construction period.

Rapid socio-economic change may accentuate existing social disparity in the region. Households and communities that already have advantages in terms of available resources, productive land and irrigation systems, access to markets and higher levels of education are likely to be able to take advantage of opportunities that arise from project activities and indirect impacts. Many outsiders that move into the area seeking economic benefits are likely to have greater skills, more financial resources and education than the local population. For both the **5-year** and **20-year** perspective it is predicted that there is likely to be a growing gap between households, between rural and urban populations and possibly between men and women as the primarily agriculturally based economy diversifies

and becomes more market-oriented and more services activities increase. However, as with the Nakai Plateau, the incidence of poverty is likely to decrease and the 'poverty gap' is not predicted to be significant due to project mitigation and opportunities for socio-economic development in the area.

7.4.3 Summary of Impacts

Table 26: Summary of the most Important Cumulative Impacts in Xe Bangfai Basin

Xe Bangfai Basin and Surrounding Districts	
5-year scenario	20-year scenario
<p>The impacts of the NT2 operation will have started to be felt. In addition, the new Road 12 will have significant impacts. The cumulative impacts are likely to be:</p> <ul style="list-style-type: none"> • Increase in untreated wastewater due to population increase around Gnommalath and Mahaxai may add to the oxygen depletion problems caused by the reservoir and make the water less fit for consumption and fish production. • Higher pressure on biodiversity in terms of hunting and logging due to influx of people and improved access to the area. Improved management and enforcement efforts in the Nakai Nam Theun NBCA might increase the pressure on other NBCAs. • There will be commercialisation and intensification of agriculture in Mahaxai and Gnommalath, but the irrigated rice area will yet only be moderately expanded. • Logging in undisturbed forest and other areas will increase. • Gnommalath and Mahaxai urban areas will expand considerably, possibly experiencing a doubling of the population while ad hoc planning will characterises the expansion of settlements. • STI and HIV/AIDS prevalence will have increased and vehicular accidents will have become more common. • The capacity of the various district services will have been strengthened considerably due to NT2 Project support. 	<p>No new large-scale hydrological changes are foreseen, but the transport corridors and accompanying urbanisation will be a significant development in relation to cumulative impacts. In summary the impacts are likely to be:</p> <ul style="list-style-type: none"> • The oxygen depletion problem will be reduced due to less organic matter in the reservoir and better wastewater treatment. • Agriculture developmet will cause local eutrophication problems. Hightened levels of pesticides in drainage water and consequently in fish, might be experienced. • Change in flow regime may have lowered biodiversity and fish production due to disturbed spawning cycles. On the other hand increased flooding may have increased flood plain and "back swamps" production of fish. • There will be better sanitation, health services and improved awareness on health issues. Water-borne illnesses and intestinal parasitic infestations will have been substantially reduced as will mortality caused by malaria and dengue fever. • The District centres of Mahaxai and Gnommalath will have grown substantially, possibly with more than 200% while the population of Thakhek may have increased with more than 140%. The service sector including tourism will grow and the cement industry in Mahaxai will have expanded and created more employment. • Some assimilation of ethnic minority groups in urban areas will have occurred, but cultural identity will to a larger extent be retained in rural areas.

7.5 Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts

7.5.1 Introduction

In this zone the impacts from the NT2 project will primarily be impacts related to the hydrological changes caused by the transfer of water away from the Nam Theun, which today is providing water to the Theun-Hinboun hydropower project. In the cumulative impact perspective the changes caused by the NT2 will be combined with the assumed impacts caused by the planed Theun-Hinboun Extension project, which is assumed to be implemented in the same period.

7.5.2 Impact Predictions

Hydrology and Vulnerability to Flooding

In the Nam Theun/Nam Kading/Nam Hinboun river system, the relevant planned hydropower projects include the NT2 and Theun-Hinboun Extension (including the Nam Theun 3 reservoir). Both projects are envisaged to be in operation by **2010**.

In the following section, the predictions for the **5-year** perspective are carried out for two alternatives; the impacts of NT2; and for NT2 together with Theun-Hinboun Extension. The impacts are compared to the baseline, which includes the hydrological regime imposed by the existing Theun-Hinboun operation.

Apart from occasional spilling during floods, only 2 m³/s will be released into Nam Theun downstream the NT2 dam. As tributaries join Nam Theun downstream, the discharge increases. Figure 2 below shows the pre- and post-NT2 discharge into the Theun-Hinboun head pond. Of the local runoff between NT2 dam and TH head pond, more than 50% is inflow from Nam Gnouang, a large tributary joining Nam Theun immediately upstream of the Theun-Hinboun head pond.

The reduction of the inflow to the Theun-Hinboun head pond due to NT2 will on average be approximately 55%. The energy generation at Theun-Hinboun will be affected to a lesser degree because a larger proportion of the flow diverted at NT2 is floodwater, which is spilled over the Theun-Hinboun dam also in the pre-NT2 situation. As a total, the turbined water volume at Theun-Hinboun will be reduced by 20%, but up to 60 % in dry season months.

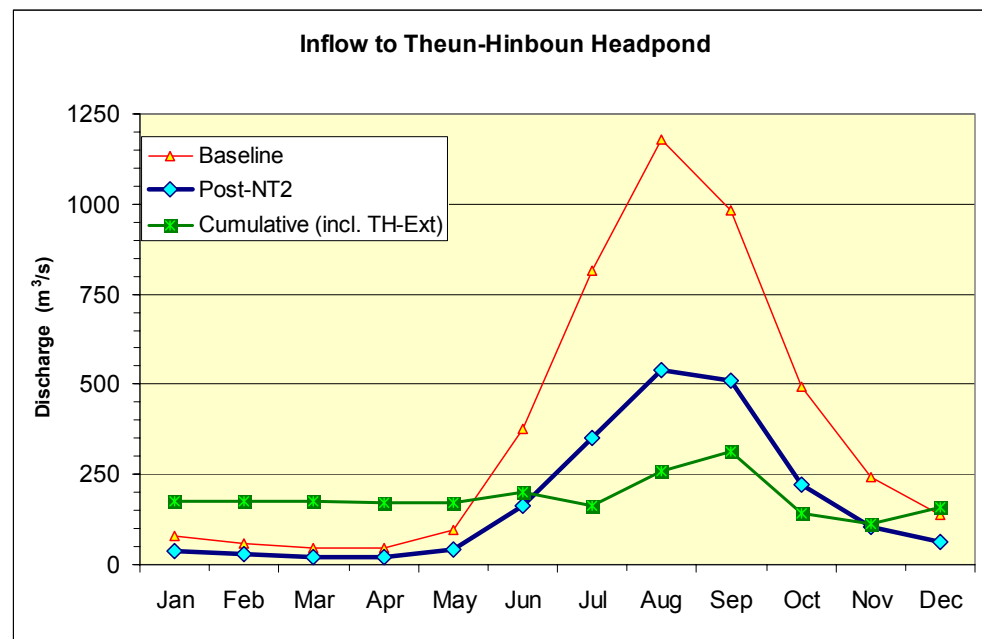


Figure 2: Cumulative Impact of Discharge into Theun-Hinboun Headpond.

The reduction of energy generation at Theun-Hinboun due to NT2 is one of the incentives to plan for Theun-Hinboun Extension, which includes an increase in installed capacity and the erection of a dam on Nam Gnouang. The dam will regulate the runoff from this tributary to counter-balance the loss of water from the Nam Theun, so that the total inflow to Theun-Hinboun head pond becomes

as constant as possible (Figure 2). This will enable Theun-Hinboun to increase power generation significantly.

In Nam Kading downstream Theun-Hinboun dam, the impact from **NT2 alone** is a reduction of the discharge in the flood season June-October. The average reduction in August will be from 1880 to 1240 m³/s or 35% at Pakkading (Figure 3). The period with spills over THB dam will be reduced from an average 245 days per year to 190 days per year. As a result of NT2, THB will be able to divert all the inflow in the dry season, so only the minimum release of 5 m³/s will be discharged into Nam Kading.

Including also the Theun-Hinboun Extension, the *cumulative impact* will be that a larger part of the water that enters the Theun-Hinboun headpond will be diverted into Nam Hinboun, thereby further reducing the spills into the Nam Kading. As shown on Figure 3, the cumulative reduction of discharges in Nam Kading in August is from 1880 m³/s (baseline) to 960 m³/s or 50%.

In Nam Hinboun the impacts from the NT2 alone will be a reduced flow, due to a reduced inflow to Theun-Hinboun headpond. As shown on Figure 4, the flow reduction is most significant in the dry season. It should be remembered that the baseline situation is not the natural flow, but includes the existing operation of Theun-Hinboun.

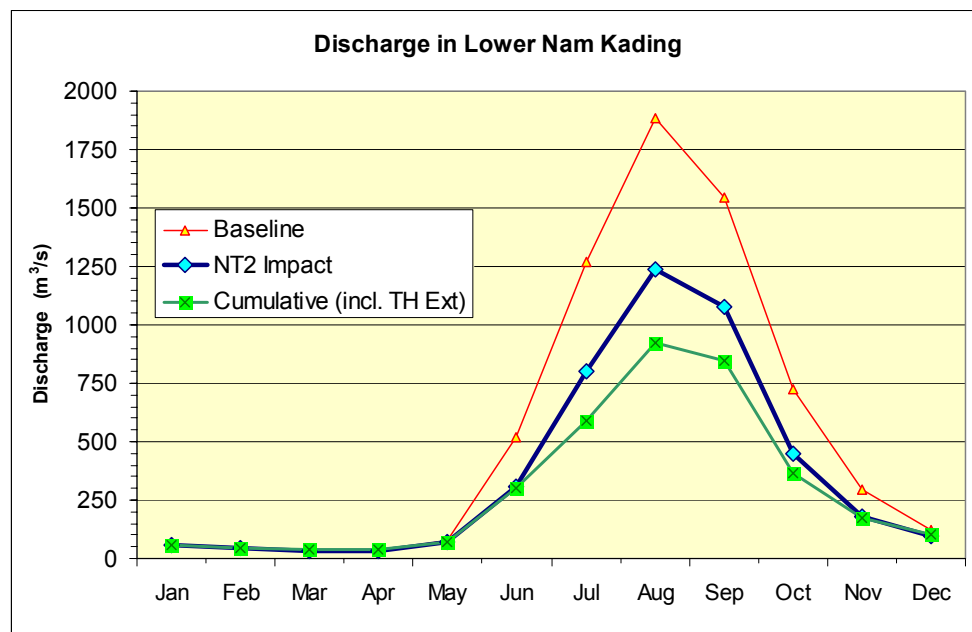


Figure 3: Reduction of Flow at Pakkading (downstream Theun-Hinboun dam).

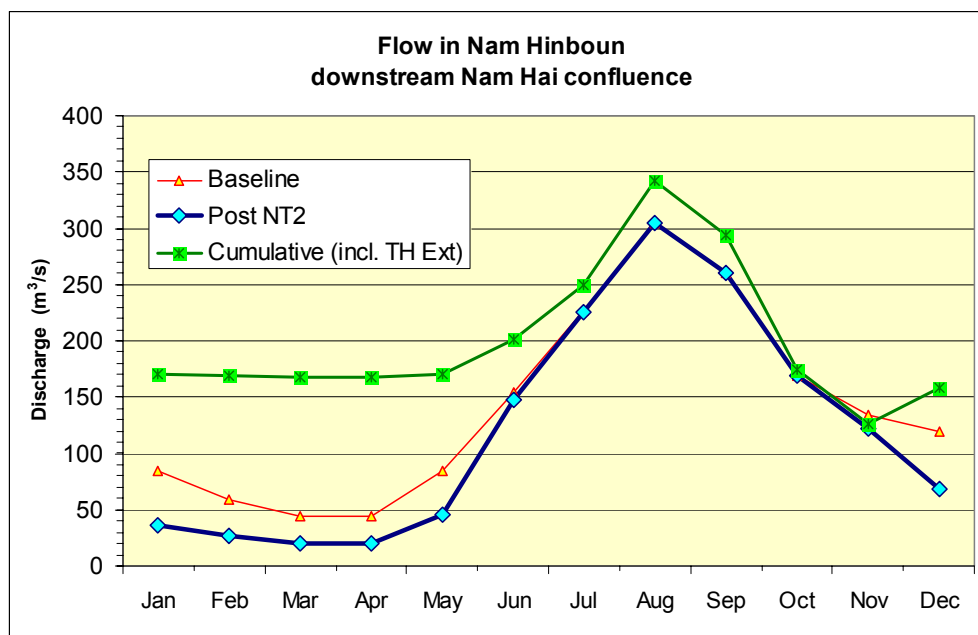


Figure 4: Changes in Flow in Nam Hinboun.

With the Theun-Hinboun Extension implemented, the cumulative impact will be a moderate flow increase in the wet season and a large increase in the dry season. This is due to Theun-Hinboun Extension's operation rule, which is to counterbalance the flow variations in Nam Theun as much as possible. As a result, the cumulative impacts will increase the wet season flow by around 12%, while the dry season flow is increased by 300% to 170 m³/s.

Impacts of **NT2 alone** on the water quality of downstream of the Nakai dam are studied in the ongoing Riparian Release Project.

In the **5-year** perspective it is assumed that both the NT2 and the Theun-Hinboun Extension are in operation and thus the water flow regime will be significantly changed in Nam Kading and in Nam Hai/Nam Hinboun compared to the isolated impacts of NT2 (see above).

The release of only minimum flow downstream of the Nakai dam will reduce the recipient capacity of the river. In addition the first year after commissioning the water released from the Nakai reservoir will have low oxygen content, due to organic materials in the reservoir. The water will be oxygenated as it flows in the rapids downstream and the water quality will be partly restored by the release of water from Nam Phao.

The district centre of Lax Xao will have been provided with a water supply system. Piped water supply will result in increased discharges of wastewater, which in this case will be into the Nam Phao. The population of Lax Xao is predicted to reach 17,500 in this period. Assuming a production of 3g tot P and 12 tot N per person per day, and that 50% of this reaches the river (a high estimate), the impact in river water concentration in the low flow season (5 m³/s) will be 61.2 µg/l tot P and 245 µg/l tot N. This is a distinct elevation from the level of round 10-15 µg/l tot P and 100-200 µg/l tot N found in the upper tributaries of Nam Thun. However, based on the average flow situation (40 m³/s) the contribution is rela-

tively smaller. The nutrient load and the microbiological contamination will first of all create a local problems in the near downstream areas. Its influence on lower Nam Theun water quality will most likely be marginal.

The influence for Nam Kata mining activities on downstream water quality is a potential serious problem.

In the Nam Hinboun the recipient capacity to dilute the heavy metals and iron contained in the discharges from Nam Pathen, will increase significantly in the dry season when the Nam Hinboun flow volumes will be 2-3 times what it is today (see *Figure 4*). However, lacking monitoring of metal concentrations and loads from Nam Pathen makes it impossible to assess the impact in more precisely.

In the **20-year** perspective the basic water quality conditions will not be changed. The only relevant development foreseen is increased wastewater generation from the expanding Lax Xao town. It is assumed, however, that a sewerage and wastewater treatment system will have been installed by that time, efficiently reducing nutrients, organic mater and pathogens in the wastewater. Local water pollution problems will still be experienced in the recipients downstream the town, but the situation in the Nam Phao is likely to have stabilised before its confluence with Nam Theun.

Fisheries and Aquatic Biodiversity

When in operation the NT2 dam will release 2 m³/s (+) below the dam into the Nam Theun. About 10 km downstream the reduced flow will be partly alleviated by the inflow of Nam Phao (average flow about 60 m³/s). The Theun-Hinboun head pond is located approximately 60 km further downstream. The other significant tributary Nam Gnouang discharges just upstream of the head pond. The specific impacts of the proposed water release from the Nakai dam are presently being studied in the "Riparian Release Study".

The present operation of the Theun-Hinboun power plant has resulted in a significant reduction in water flow in the Nam Kading. The riparian flow is set at 5 m³/s. In the wet season, however, is additional water overtopping the dam and released downstream into the Nam Kading. Interviews with fishermen and villagers in the areas of the lower Nam Kading near to the Mekong confluence in 1998 and 1999, most of the people considered that low fish catches during that period were attributable to a reduction in dry-season / early wet-season flows caused by the Theun-Hinboun dam (Warren 1999). In the head pond reach the establishment of a "reservoir" fishery seems to have compensated for the original river fisheries. A change in species composition has been observed.

In the Nam Hai and Nam Hinboun the operation of the Theun-Hinboun is reported to have had negative impact on fisheries, primarily because of erosion problems and high turbidity. Other impacts are more difficult to assess. Increased flow seems to have changed migration pattern, reducing some fisheries and increased others. However, the long-term impact of these changes is still unclear.

With the **NT2** project in operation the period of flood overspill will be significantly reduced, and the existing problems for fisheries and fish migration further downstream Nam Kading increased. NT2 operation will also lead to a decrease in inflow to the TH head pond. The reduced flow will further reduce the riverine fea-

tures of the pond and strengthen its “lake” characteristics. This might also cause changes in species composition.

In Nam Hai and Nam Kading the operation of NT2 will reduce the dry season flow (partly back to the pre Theun Hinboun situation).

In the **5-year** perspective both the NT2 and Theun-Hinboun Extension project, will likely be in operation. This TH Extension project will further reduce wet season flow in the Nam Kading. The detailed hydrological impacts of NT2 and Theun-Hinboun Extension on the flow in Nam Kading and in Nam Hinboun were presented in the hydrology section above.

Reductions in wet season flow volume will have a negative effect on fisheries in Nam Kading. During the dry-season period, more water will be available from the NT3 than at present, but this will be diverted into the Nam Hinboun Basin. It is not assumed that the storage water will be used to increase the present environmental flow releases of 5 m³/s into Nam Kading. The reduction in flood periods and consequently the water overtopping the weir will affect fish migratory behaviour to some extent below the dam and will probably make any ascent by migratory fish (not very significant at present) past the Theun-Hinboun dam impossible.

The impacts to fisheries in the Nam Hai/Nam Hinboun might be increased after NT3 is built as the flows will increase during the dry-season period, which will further increase the bank erosion and sediment load. The storage of water in NT3 will result in lower oxygen content in the water and lower temperature in the water transferred to this basin, and thus have an impact on fisheries and aquatic life.

No additional hydropower development or other larger project that might change the hydrology of the rivers and thus the fisheries is expected in the **20-year** perspective. An additional aspect that might cause negative impacts to the fisheries and aquatic biodiversity is, however, the mining activities on the lower tributaries to Nam Hinboun. If the activity is expanded and or the mines are closed down without proper clean-up or pollution control, the discharges of heavy metals will be of serious concern.

Terrestrial Biodiversity

The most important areas in this impact zone are Phou Hin Poun NBCA, Nam Kading NBCA and the Nam Chat/Nam Pan Provincial Conservation Forest. In addition, the Nam Theun-Phou Hin Poun Corridor straddles the border between this impact zone and NNT NBCA in the south. Parts of the Nam Gnouang catchment, including the dam site of the proposed NT3 reservoir is proposed as the “Pha Kadoung Saola Management Area” IUCN, 2000.

The area along the Mekong river (west of Nam Kading and Phou Hin Poun NBCAs) and the central eastern part the catchment, from Lak Xao through the central parts of Viangthong District, have been subject to years of intensive logging and conversion of forest into agricultural land. In these areas, only fragments of primary forest remain.

In the **5-year** perspective, it is expected additional pressure on the natural resources and biodiversity caused by the combination of population growth and unsustainable forest and land management. In particular, improved road conditions locally and to Vietnam (Route 8A) might facilitate increased trans-border

trade in wildlife and timber, and thereby also increase the pressure on the NBCAs further away from the border. The establishment of the NT3 reservoir (part of Theun-Hinboun Extension project) will inundate large tracts of forests hosting a population of the endangered Saola.

In the **20-year** perspective, the pressure on terrestrial biodiversity will continue to increase due to a general population growth and an increased movement of people and goods through the transport corridors. As previously mentioned, Nam Kading NBCA, Phou Hin Poun NBCA and Nam Chat/Nam Pan Provincial Conservation Forest are unlikely to receive the same protection and control of illegal activities as Nakai-Nam Theun NBCA. Hence, there is a certain risk that the pattern of illegal logging and hunting, will shift from Nakai Nam Theun NBCA to the other, less protected NBCAs in this region.

Agriculture and Forestry

On the upper Nam Theun there are some limited irrigated areas upstream the point where Route 8 crosses the Nam Theun. Presently irrigated areas on this reach cover only around 445 ha while the potential for expansion has been estimated to 196 ha. Along the tributaries to Nam Theun comprising Nam Nyuang, Nam Phao and Nam Kata there are some larger irrigated areas with an identified potential for expansion amounting to around 1,300 ha. Apart from the limited irrigated areas that presently exist upland shifting cultivation and semi-permanent cultivation dominate agricultural practices.

Along the whole length of the Nam Hinboun present irrigated areas amount to around 6,000 ha. Total potential for expansion is around 5,000 ha in the wet season. Along the Nam Kading no significant irrigated areas are found and there is no significant potential for reclaiming any land for irrigation. Most of the area along Nam Kading consists of forest of varying density and forest mosaic and shrubland. There is little agricultural activity apart from presumably scattered patches of shifting cultivation.

In the **5-year** perspective agriculture will still be dominated by shifting cultivation but the fallow period will have been narrowed down to 3-4 years in some areas while it will be nearing permanent cultivation in others. This will reduce soil fertility and yields seriously as the intensification of land-use will probably not have been accompanied by proper and adapted production technologies and increased inputs in terms of manure and fertilizer. Possibly up to 50% of the potential area for irrigation expansion will have been utilised along the Lower Nam Theun and its tributaries, and along Nam Hinboun. For Nam Theun itself it will only mean an additional 100 ha while for the tributaries of Nam Phao and Nam Kata it will increase wet season irrigated area with 600-700 ha. Similarly, along the Nam Hinboun a 50% expansion of wet season irrigated areas of the potential for expanded irrigation will add 2,000 to 3,000 ha. The foreseen developments in the agricultural sector are not expected to have any impact the on hydrological regime and flow patterns in the zone that will significantly to effects caused by other sectors such as hydropower.

In the **20-year** perspective a considerable part of what today is shifting cultivation areas will have come under permanent cultivation, while yields will still be quite low because of the lack of sufficient inputs and application of appropriate technology. Most likely all of the irrigation potential along the Nam Theun and its tributaries and along Nam Hinboun will have been developed. Along Lower Nam Theun the total wet season irrigated area may have reached approximately 650 ha while total irrigated area along Nam Phao/Nam Kata may have increased to

around 2800 ha. Development of all remaining potential irrigable land along the Nam Hinboun will bring the total area up to around 11,000 ha. The intensification of land-use and development of the irrigation potential in the zone are not expected to contribute significantly to cumulative effects on the hydrological regime caused by other development sectors.

Urban Development and Population Growth

The only proper urban centre in this zone is Lak Xao. According to the Lao Urban Databook (ADB 2003) it has a population of 12,744. The growth rate in the past years has been estimated to be around 2.7% (Norconsult, 2003) Being the only urban area in the south-eastern part of Boulykhamxay and a focal point for trade and transport services with established warehouses, Lak Xao is also expected to grow at a relatively high rate also in the future. The main driving force behind the urban expansion will be the improvement of Route 8 and the transport and trade associated with regional economic integration, in particular the Lao and Vietnamese economies. It is not foreseen that the NT2 development will be a major factor behind the growth of Lak Xao in the future. The reason for this is the distances between the major centres of NT2 project activity, the nearest being the damsite situated some 20 km from Lak Xao while the distance to the intake structure and the power station is 50-60 km. In addition to this comes the fact that the main supply routes for the NT2 Project will be Route 12 and Route 8B. These are being upgraded by the Project but it is uncertain whether the section of Route 8B between the dam site and Lak Xao will be substantially improved.

Assuming an annual growth rate of 3% in both the **5-year** and **20-year** perspective the population of Lak Xao will increase from around 12,800 in 2003 to 17,000 - 18,000 in 2010. This represents an increase of more than 33%. With the same continued growth rate of 3% the population of Lak Xao will reach 27,000-28,000 in 2025, an increase of more than 110%.

The growth of Lak Xao will most likely be a mix of planned and unplanned developments with settlements springing up on the periphery of town which will not be included in the expansion of water supply and sewer systems.

Health

In the **5-year** perspective the direct, as well as cumulative, health impacts in this zone are expected to be minimal. A work camp will be established for construction of the dam site and Road 8B north to its junction with 8A near Lak Xao. This work camp, and possible ad hoc camp follower settlements that may spring up here, are dealt with in the project specific impact assessments. As there are no established villages or settlements close to this site, significant health impacts are not expected except for those faced by the labour force and the camp followers. Further downstream in the Nam Theun, Nam Kading and Nam Hinboun Basins and surrounding districts no cumulative health impacts are foreseen. It is expected that the specific health interventions in connection with the NT2 project will limit and keep the spread of HIV/AIDS in check in the workers camp area.

In the **20-year** perspective other developments than NT2 will dominate. Route 8B from the damsite to Lak Xao may have been improved to support a higher traffic volume. Traffic will increase substantially which may lead to an increase in vehicular accidents and in roadside establishments. Increased traffic will also entail an increased risk for the spread of HIV/AIDS.

Ethnic Minorities

The ethnic population of Khamkeut District of Bolikhamxai, including the town of Lak Xao, is very mixed. The majority residing in this district belong to the broad category of *lao loum* or lowland groups, including various Tai sub-groups. There are also populations of Hmong, Mon-Khmer (Brou) and smaller groups, including Vietic (Maleng) along the areas bordering the NBCA. Like other districts in and adjacent to the NT2 project, there is likely to be increased integration in terms of social, economic and cultural development. A particular concern for this region are the small vulnerable Vietic groups who are more susceptible to assimilation due to their small population numbers, relative isolation, reliance on natural resources and lack of understanding of market forces. Their future is uncertain at a time of rapid socio-economic change.

Another issue is the swidden practices of the Hmong adjacent to the NBCA and the potential threat to biodiversity. In the **5-year** perspective, the most likely situation will consist of the gradual integration of groups into the mainstream economy being sped up slightly by NT2 project-related activities, population influx, increased urbanisation, consolidation of smaller groups into larger village administrative units, improved infrastructure and growth in the service sector. A study of migration and population change along Route 8 conducted as part of this study reveals the following trends (Table 27):

Table 27: Population and Migration along Route 8 (1995-2003)

Unit	1995	2003
Abandoned village	-	28
New Administrative Units	-	27
Size: 0 - 50 households	45	2
Size: 50 - 100 households	10	14
Size: < 100 households	8	29

Almost all small Vietic groups are now resettled in larger villages or part of new administrative units

In the **20-year** perspective, it is likely that smaller ethnic groups in or near Lak Xao, including some Vietic populations, will become more assimilated and may lose their ethnic identity to a large extent. Groups related to Lao, such as Phou Thay and Tai sub-groups, are likely to become fully assimilated in urban areas, but in rural areas cultural differences will continue to some extent. Buddhism will replace some local beliefs and the Lao language will gain ground, leaving local languages and dialects only the domestic sphere for expression. Hmong cultural traditions and language are likely to continue despite changes in the socio-economic condition due to the fact that Hmong clan structure is strong and there is a large network of Hmong groups within Lao PDR and abroad.

Poverty Alleviation

NT2 mitigation will not directly effect this area except for the relocation of Tai villagers from Sop Hia village on the Nakai Plateau to a new location to the south-east of Lak Xao. In terms of poverty, some of the highest incidents in the country

were recorded in Bolikhamxai. The town of Lak Xao is probably an exception and likely to experience growth and development due to the planned upgrading of Route 8.

It is likely that social disparity may increase due to a lack of available land for agriculture and continued population influx. This area will not benefit directly from extensive mitigation or infrastructure improvement initiated by the NT2 project. Households having primarily subsistence-oriented economies will continue to struggle to make ends meet. Differences between income levels and standards of living between rural and urban areas may continue to increase, although rural areas may also benefit from some of the improvements in infrastructure and greater availability of services and employment opportunities. Gender relations in urban areas may change in that men will become the main or primary earner unlike the complementary socio-economic situations for men and women in rural areas.

7.5.3 Summary of Impacts

Table 28: Summary of the most Important Cumulative Impacts in Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding District

Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts	
5-year scenario	20-year scenario
<p>Nam Kading and Nam Hinboun will experience the combined impacts of the NT2 and the Theun-Hinboun Extension projects, in addition to the developments caused by the improvement of the Route 8 corridor, and increase in cross-border trade and population movement. The predicted impacts are:</p> <ul style="list-style-type: none"> • In Nam Kading downstream Theun-Hinboun dam, the impact from NT2 will reduce the discharge in the flood season. Adding Theun-Hinboun Extension, the cumulative impact will be that a larger part of the flood spills over Theun-Hinboun dams will be diverted into the Nam Hinboun, thereby further reducing the spills into the Nam Kading. • The reduction in flood periods will affect fish migratory behaviour and will probably make any ascent by migratory fish (not very significant at present) past the Theun-Hinboun dam impossible. • There will be increased threats to biodiversity due to population increase and increased trans-border traffic. However, the WCS wildlife conservation project will tend to counteract the negative development trend. • The remaining and limited forested areas will be increasingly encroached upon but participatory village forestry will have been introduced. • Irrigated areas and irrigation schemes will increase along Nam Hinboun. • Lak Xao will increase to a population of 17,000 – 18,000, representing a growth of more than 33% in relation to present number of inhabitants.. Part of the growth will be due to in-migration. 	<p>No additional hydropower expansion is planned in the basin. The development will be dominated by the increase in transport related activities and impacts and developments on the Plateau. The main impacts will be:</p> <ul style="list-style-type: none"> • Nam Kading NBCA, Phou Hin Poun NBCA and Nam Chat/Nam Pan Provincial Conservation Forest are likely to experience an increased pressure of cultivation, logging and hunting as a result of improved protection of Nakai-Nam Theun NBCA. • The rural urban migration trend will be reinforced and the size of Lak Xao will have grown to 27,000 –28,000, an increase of more than 110% over todays population • It is likely that smaller ethnic groups in or near Lak Xao, including some Vietic populations, will be fully assimilated and will lose their ethnic identity. • Hmong cultural traditions and language are likely to continue despite changes in the socio-economic conditions in the area.

<ul style="list-style-type: none"> • Gradual integration of ethnic groups into the main-stream economy will speed up slightly due to NT2 project-related activities, population influx, increased urbanisation, improved infrastructure and growth in the service sector. • The vulnerable Vietic groups will be under particular pressure of integration. 	
--	--

7.6 Mekong River Basin

7.6.1 Introduction

The downstream impacts in the Mekong River Basin are all a consequence of changes in hydrology. The changes caused by the Nam Theun 2 Project are here added to other activities in the basin that have an influence on water flow and water quality, in particular other hydropower projects and development of irrigation. In the sections below the impact analyses contain discussions of the downstream impacts of **NT2 alone** in addition to the **5-year** and the **20-year** combined development perspectives.

7.6.2 Impact Predictions

Hydrology and Vulnerability to Flooding

The hydrological regime of the Mekong in the period 1925-2000 is characterised by a gradual decrease of annual flows. The reason for this trend is not clear, but it has been argued that the main reason would be the expansion of the area under swidden cultivation in this period. Assuming that this trend will continue, the discharges in the Middle and Lower Mekong are projected to be 8% lower in the period 2005-2025 compared to the reference period. Therefore the hydrological simulations in this study have used a (1950-2000) baseline reduced by 8% as input to the models. For details see Annex 2.

Floods are a chronic event in the Lower Mekong Basin. Floods result in loss of life and property, damage to agriculture and rural infrastructure. At the same time flooding of the Mekong floodplains and Cambodia' Great Lake positively impact biodiversity and fish production, and in addition the floods provide sediments that are important for soil fertility. Severe floods were experienced in Cambodia and Vietnam in 2000 and 2001. In Cambodia 347 people lost their life in 2000 and 62 in 2001. In Vietnam the death toll was more than 500 in 2000 and 230 in 2001. The total physical damage was in 2000 calculated to be USD 161 million in Cambodia and USD 285 millions in the Vietnamese delta.

The flow situation in the Mekong Delta is strongly influenced by tidal movements. Due to quite large tidal amplitude (up to 3 m), sea water is "pumped" quite far upstream through the Mekong branches. The tidal movements are visible on water level records as far upstream as Phnom Penh during the dry season, although seawater itself does not intrude so far. Seawater intrusion is a significant environmental problem in the Delta and has increased due to the general decrease in the Mekong runoff. Saltwater intrusion is particularly a problem for the use of river water for irrigation in the Delta.

Regulation by hydropower is beneficial in this context because it increases the dry season flow and therefore reduces saltwater intrusion. The hydraulic model includes results concerning seawater intrusion. It should, however, be noted that

the Delta is described in a rather simplified way in the model, and the results should be considered as indicative only.

Impacts due to **NT2 project** alone will cause no flow change in the Mekong at Pakkading (confluence with Nam Kading) in the dry season. Theun-Hinboun will be releasing only the minimum 5 m³/s into Nam Kading both with and without the NT2. In the heaviest flood season, NT2 will reduce the spills over the Theun-Hinboun dam by approximately 650 m³/s as an average for the month of August. In the Mekong it is in July that the proportion of the change is largest because of different flood timings in the two rivers. The *average* wet season flow reduction in the Mekong downstream Pakkading is 4% in July. In 10% of all years, the July flow reduction will be *less than 2%* and in other 10 % of all years the reduction will be *larger than 7%*.

Downstream Pakhinboun, where the Theun-Hinboun diversion returns to the Mekong, the impact in the flood season is about the same proportion as upstream Pakhinboun, a 4% reduction on the average. In the dry season however, there is a flow reduction which was not seen upstream Pakhinboun (Figure 6). The reason for this dry season flow reduction is that pre-NT2, the Theun-Hinboun diversion returns to the Mekong at Pakhinboun. Due to the NT2, the flow diverted into Nam Hinboun by Theun-Hinboun is reduced by approximately 25 m³/s in April, or 1.7% of the Mekong April discharge. This amount of water is thus “moved” from Nam Hinboun to Xe Bangfai by NT2.

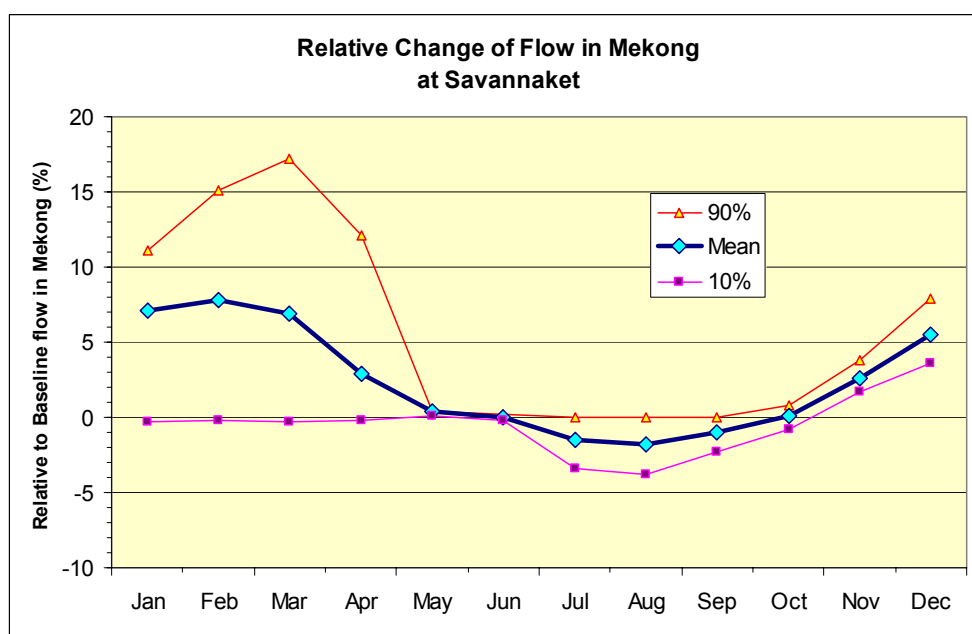


Figure 5: NT2 Impact on Mekong Discharges at Savannakhet

In terms of water levels in Mekong this translates to a reduction in the dry season of about 2 cm between Pakhinboun and the confluence with Xe Bangfai. In the wet season the reduction will be in the range 23-29 cm, with the larger value at Pakkading and the smaller at the Xe Bangfai confluence. For comparison water levels naturally vary in the range 7.5-11 m for the flood season when the 80% most frequent years are considered. For the dry season (April), the natural range of variation is 0.6 m.

Between Pakhinboun and Xe Bangfai outlet both the dry season reduction and wet season reduction of water levels are marginal compared to the normal Mekong flow. The need for additional pumping cost for dry season irrigation and water supply will not be measurable. A slight reduction in wet season flooding and reduced backwater effect in tributaries might be seen on the Thai and Lao PDR side of this Mekong reach. The combined impact on the water flow changes on the Xe Bangfai floodplain will be addressed in the ongoing Xe Bangfai Downstream Study.

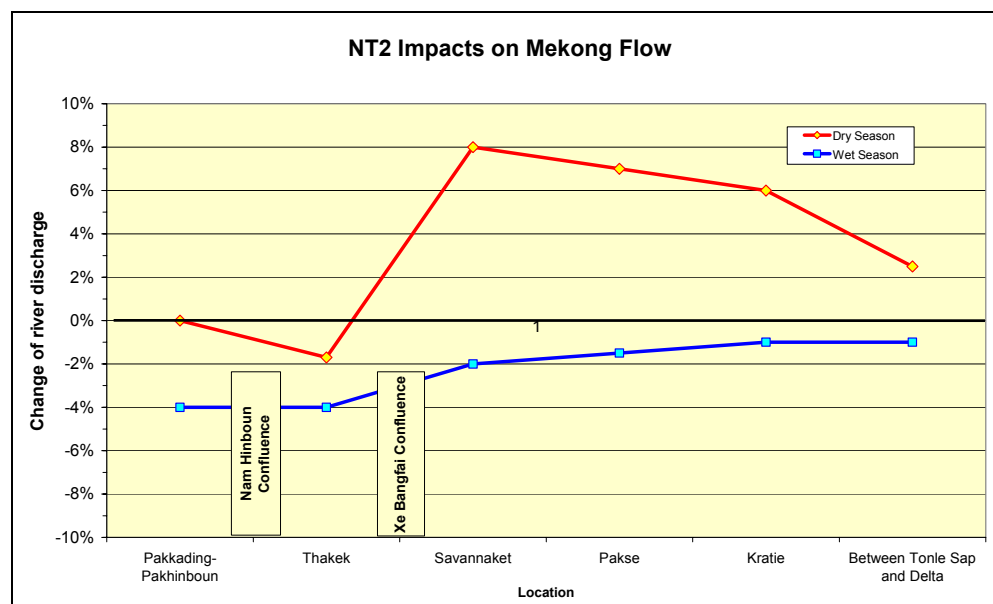


Figure 6: Summary of NT2 Impacts on the Mekong, as relative flow changes.

Figure 6 summarises the impacts of NT2 along Mekong. At Pakse and Kratie, the flow modifications are identical to those reported for Savannakhet, but as a *proportion* of the flow they are slightly smaller, due to the increased Mekong flow as one moves downstream.

The Mekong river section with the largest relative impact from NT2 in the dry season is the section around Savannakhet with 8% increase of the dry season flow: from 1790 to 1930 m³/s. According to the rating curve for Mukhdahan gauging station this corresponds to an increased dry season water level (gauge) of 8 cm.

The impacts on the Great Lake system were simulated with a hydrodynamic river model, described in Annex 2. In the wet season, the Mekong water level at Phnom Penh is reduced by 3 cm. The reduction causes a reduced inflow to the Great Lake of 100 m³/s, or 2% of the baseline average inflow. As a result, the simulations show that the Lake level will be reduced by 3 cm, out of a total rise of 7-8 m. This reduction should be seen in relation to the natural variation from year to year. In 80% of all years the natural year-to-year variation of the annual maximum level will vary within a range of 2.6 m.

In the dry season, the lake level will be increased due to the regulation by NT2. The lowest Lake level, which occurs in April, is at elevation 0.9 m masl on the average. This water level will be increased by 2 cm on the average.

The 3 cm reduced flood water level of the Great Lake corresponds to a reduction of the inundated area of approximately 40 km^2 . At elevation 7-8 m, the Lake circumference is approximately 530 km. Thus, an average reduction of the Lake area of 40 km^2 can be visualized as a “band” roughly 75 m wide along the entire lakeshore. This “band” will of course not be located the same place every year, as the maximum water level varies greatly from one year to another. It should be noted that this band width is meant for illustration only; in reality the Lake shore is extremely irregular and characterized by insections and many small islands. The real Lake circumference is therefore significantly longer and the “band width” smaller.

The reduced wet season flow, which is calculated to about 8 cm at Phnom Penh will have a positive but insignificant impact on reducing the risk of flood damages.

The impact on saltwater intrusion is assessed by inspecting the gauging station Tan Chau close to the Cambodia/Vietnam border. At this location, negative discharges are experienced 9.5% of the time (of the entire year) as *baseline*. Discharges are negative when the water current is going upstream due to high tide. In a **post-NT2** situation, the dry season discharge will increase so that negative discharges occur 9.4% of the time. Thus it appears that the effect is beneficial but insignificant in terms of salt intrusion.

The **5-year** perspective of upstream hydropower development will result in the dry season Mekong discharge downstream Pakkading will increase by approximately $800 \text{ m}^3/\text{s}$, or 58%. Floods will be reduced by approximately 17%, as monthly averages. For flood peaks, the reduction will be larger.

The increase of the Mekong dry season flow varies slightly (between 70% and 55% increase) as one moves downstream, depending on local inflow and whether they are regulated or not. Down to Kratie, the picture remains largely the same.

In Tonle Sap River the dry season discharge will be reduced by 7%, as the only place in the Mekong system where the discharge is reduced in the dry season due to regulation. The reason for the reduction is 1) less water is filled into Great Lake during the preceding flood season and 2) the increased water level in the Mekong reduces the pressure gradient out of Great Lake. In the Mekong downstream of Phnom Penh, the increase of the Mekong dry season flow will be 35%, i.e. considerably less than upstream of Phnom Penh. The reason for the big difference compared to Kratie and further upstream is that downstream Phnom Penh a part of the increased dry season flow is compensated by the reduced outflow from Great Lake as mentioned above.

In the flood season, floods are reduced by between 15% and 10% between Pakkading and Kratie. Generally the flood reduction diminishes when one moves downstream, due to local inflows without large seasonal regulation.

The Great Lake responds to the reduced floods in the Mekong by lowering the highest water level from 7.64 masl as a baseline to 7.42 masl in September/October, i.e. a reduction of about 22 cm on the average. Correspondingly, the lowest water level of the Lake will be increased by 25 cm to 1.14 masl. The

reduction of the Lake flood levels corresponds to a reduction of the *maximum Lake area* of approximately 355 km².

At Phnom Penh, the flood levels will be reduced by about 25 cm, which will have a positive impact on reducing the risk of flood damage.

In the Delta, the impact of increased dry season flow is a reduction of seawater intrusion. The period with negative discharges (water flowing upstream due to high tide and low flow) at Tan Chau is reduced to 8.4% of the year from 9.5% in the baseline. This corresponds to a reduction of approximately 12%.

The **20-year** perspective includes substantial planned development of hydropower, of which the largest concentration is in Yunnan, but it is substantial also in Nam Ngum and Se Kong/Xe San basins. The hydropower development plans, which are the basis for the calculations below, are described in Chapter 5.2. Development of irrigation is also taken into consideration.

The *potentially* most significant impact from irrigation is expansion of areas for dry season irrigation, which will reduce the dry season runoff. Wet season irrigation will not affect the water balance, because the areas converted to irrigation would have had a similar water consumption in the wet season also before paddies were established.

It was found that even in the most ambitious development case, the increased water consumption due to dry season irrigation was marginal; in the order 30-40 m³/s for the entire Lower Mekong upstream of Kratie. Consequently, the cumulative impacts described below can in practice be entirely ascribed to hydropower.

Due to hydropower development up to 2025 the dry season Mekong discharge downstream Pakkading will be increased by approximately 1750 m³/s, or 125%. Floods are reduced by approximately 20%, as monthly averages. For flood peaks, the reduction will be larger.

As illustrated in Figure 7 below, the relative increase of the Mekong dry season flow varies slightly (between 135% and 120%) as one move downstream, according to local inflow and whether they are regulated or not. Down to Kratie, the picture remains largely the same.

In Tonle Sap River the dry season discharge is reduced by 15%, as the only place in the Mekong system where the discharge is reduced in the dry season. The reason for the reduction is 1) less water is filled into the Great Lake during the preceding flood season and 2) the increased water level in the Mekong reduces the pressure gradient out of Great Lake. In the Mekong downstream Phnom Penh, the increase of the Mekong dry season flow is 85%, i.e. considerably less than upstream Phnom Penh. The flow increase here is smaller because a part of the increased dry season flow is compensated by the reduced outflow from the Great Lake as mentioned above.

In the flood season, floods in the Mekong are reduced from between 25 and 15% (considering average monthly flows). Generally the flood reduction diminishes when one moves downstream, due to local inflows without large seasonal regulation.

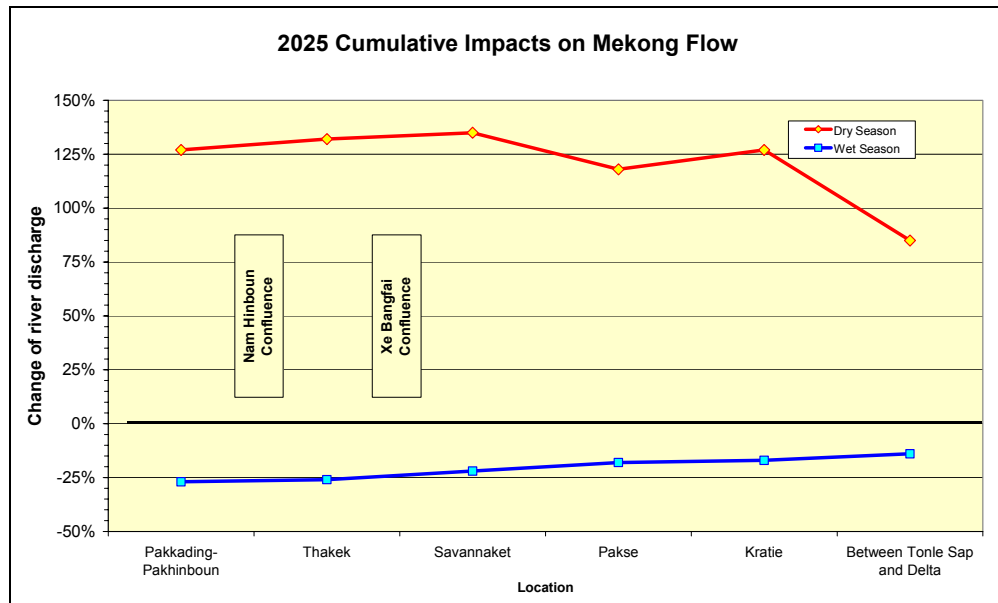


Figure 7: Summary of Cumulative Impacts on the Mekong, as relative flow changes.

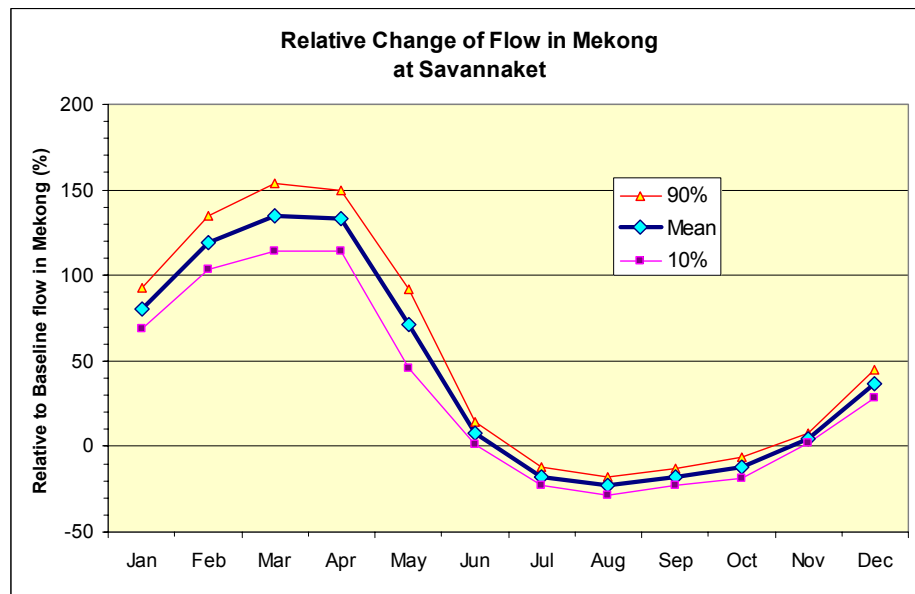


Figure 8: Cumulative Impacts 2025 on Mekong Monthly Flow at Savannaket.

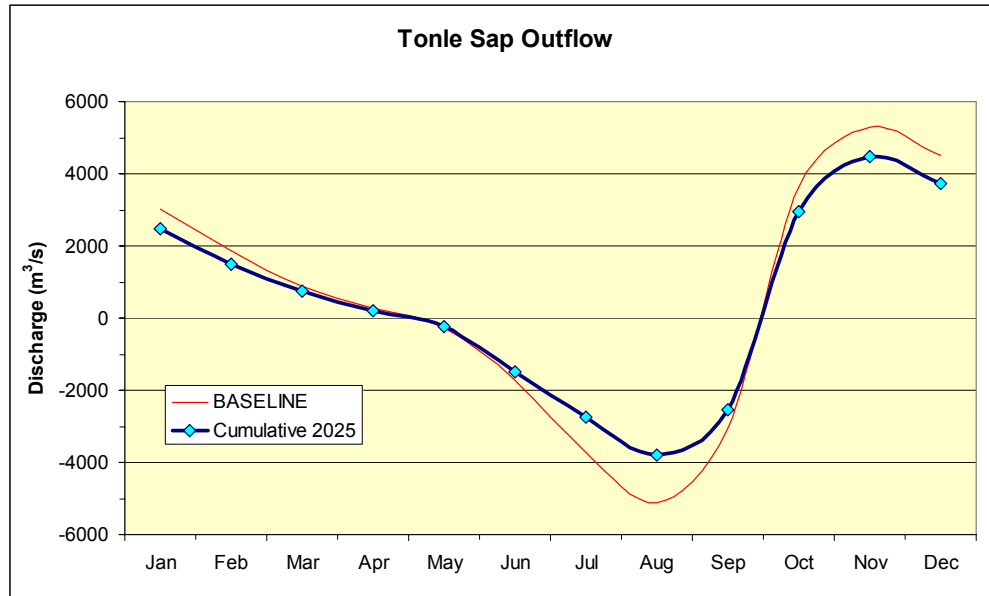


Figure 9: Cumulative Impacts 2025 on flow in Tonle Sap. Positive Flow is from the Lake to Mekong, Negative Flow is from Mekong to the Lake.

The impact on Mekong water levels has been assessed by inspecting the Mukhdahan/Savannakhet rating curve. The 135% increase of the dry season discharge (as seen on Figure 7) corresponds to a water level *increase of 1.2 m*. During floods, the discharges are reduced by around 20%. In an average year, this means from 19,200 m³/s to 15,000 m³/s in August. The corresponding *reduction of water level is 1.6 m*.

The Great Lake responds to the reduced floods in the Mekong by lowering the highest water level from 7.64 masl as baseline to 7.1 masl in September/October, i.e. a reduction of 54 cm on the average. Correspondingly, the lowest water level of the Lake will be increased by 63 cm to 1.52 masl in the dry season.

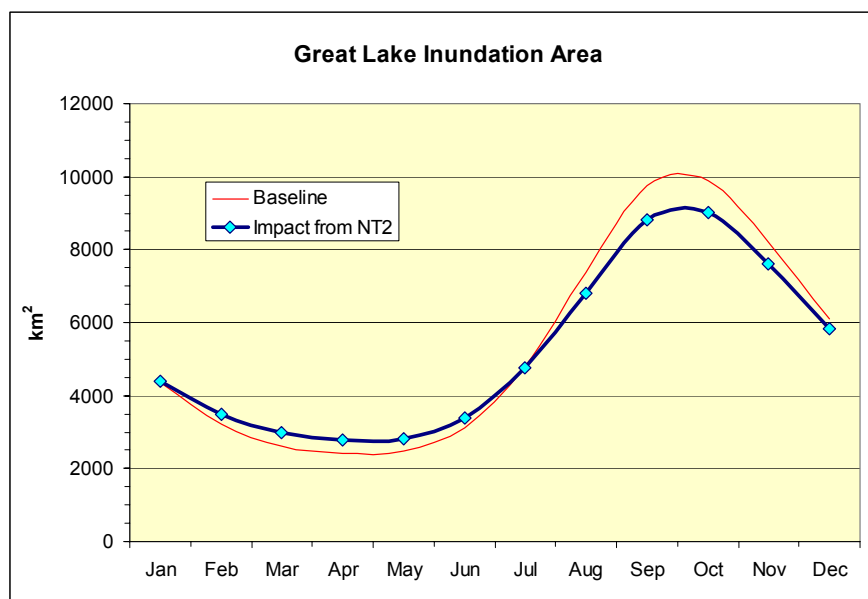


Figure 10: Cumulative Impacts 2025 on Great Lake Inundated Area.

The Lake area at maximum flood level will be reduced by approx. 865 km² to 9030 km². The Lake circumference is approximately 530 km, so the area that will not be inundated by the Lake can be viewed as a 1.6 km wide “band” around the lakeshore (Figure 10). In the real situation the non-inundated area will be different from year to year, according to the annual peak flood level, and besides the area will be very irregular as the shape of the lakeshore with numerous small islands.

The reduced wet season flow, corresponding to a reduction in level of about 60 cm at Phnom Penh, will have a significant positive impact on reducing the risk of flood damages.

The Delta will experience a significant reduction of seawater intrusion in the dry season due to the upstream hydropower development. The period with negative discharges (water flowing upstream due to high tide and low flow) at Tan Chau will be reduced to 6.1% of time from 9.5% in the baseline. This corresponds to a reduction of approximately 36%.

Table 29: Summary of Cumulative Impacts on Mekong flow at Selected Locations.

Location	2010		2025	
	Dry Season	Wet Season	Dry Season	Wet Season
Mekong at Pakkading	+58%	-15%	+127%	-25%
Savannakhet	+70%	-10%	+135%	-20%
Mekong at Phnom Penh (after Tonle Sap confluence)	+36%	-6%	+70%	-13%

Sediments

There are reports that the present sediment transport in the Mekong is about to exceed or has already exceeded its sediment carrying capacity. This is in agreement with the fact that a number of irrigation water intakes along the Mekong have problems with sedimentation.

Most large rivers may be divided into an upper erosion zone, a transportation zone of alternating erosion and sedimentation and a lower sedimentation zone, typically river plains and deltas. In lower Mekong this is the case, the transportation capacity is exceeded and the level of the riverbed is gradually increasing.

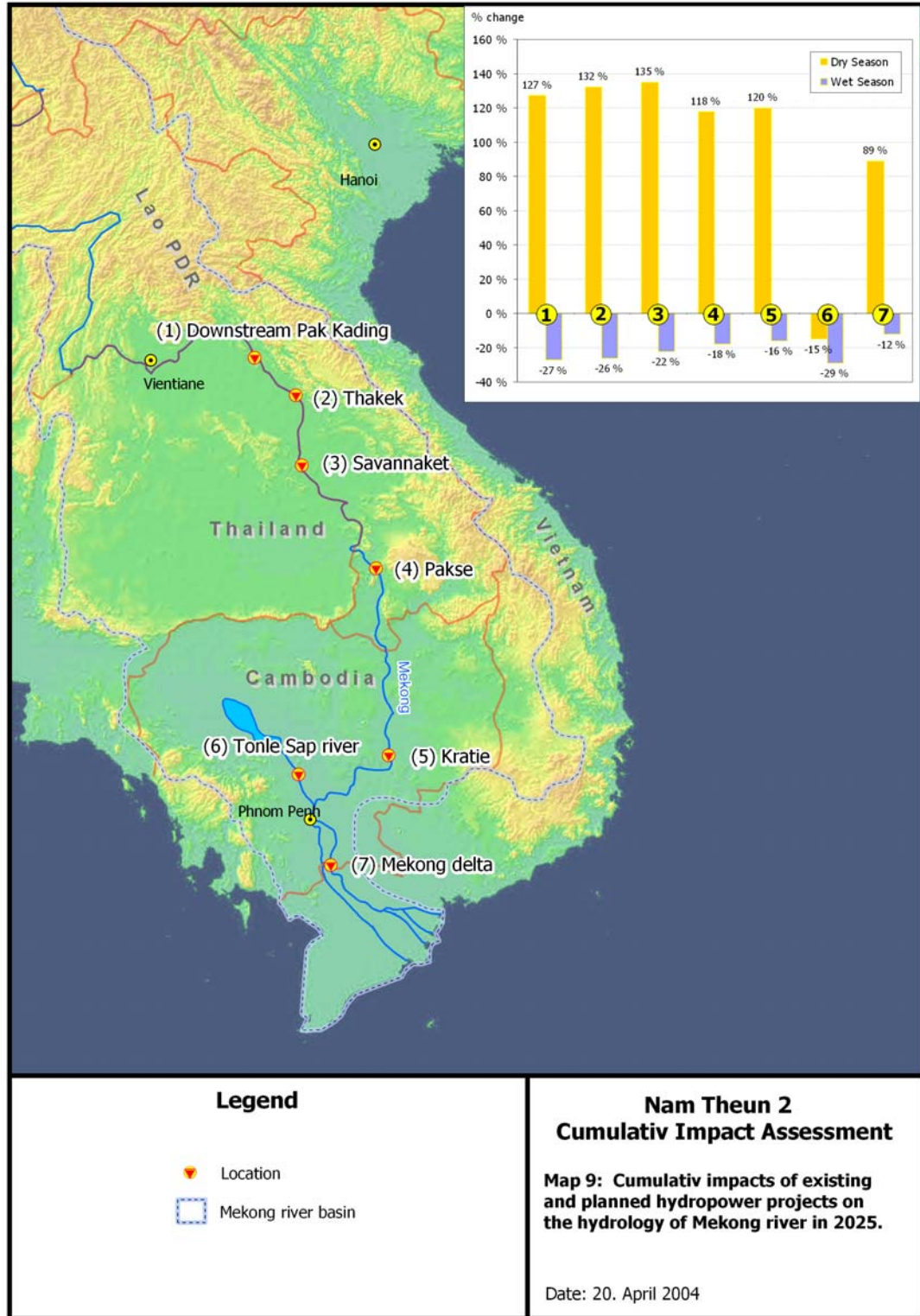
Sedimentation transport is affected by two parallel developments working in opposite directions - intensive agriculture and deforestation increases the erosion and sediment load to Mekong whereas the building of reservoirs might trap sediments. At the moment the first process seems to be the strongest and the sediment transport in Mekong is increasing. It is reported an increased sediment load of about 50 % at Pakse between the 60s and 1992 (Harden and Sundborg, 1992). The main reason has been increased deforestation and cultivation in the catchment.

In one respect there is reason to assume that sediment transport will continue to increase. Development of large reservoirs will, however, give the opposite effect, partly by trapping sediments, partly by reducing flood magnitudes.

Fisheries research concludes that nutrient rich sediment deposited in the Great Lake during floods has a positive impact on the fish production (van Zalinge et al., 2003). It is however, uncertain how much nutrients are brought in by Mekong and how much is from local runoff.

The construction of the **NT2 reservoir** will cause a negligible reduction in downstream sediment load. Only a very small amount of sediments will be trapped in the NT2 reservoir since the catchment is well forested and the inflow water is very clean. The "clean" NT2 discharge water might cause increased erosion of the riverbanks of Xe Bangfai, and it is predicted that the total sediment transport will increase in particular in the first years of operation before the river system has been stabilised. This issue is studied in more detail in the ongoing Xe Bangfai Hydrology Study.

It is difficult to predict which of the factors determining sediment loads are the "strongest" in the future. It is possible that the successive construction of dams will delay the sedimentation in the Lower Mekong for some decades. In the long run however, there is reason to believe that the deposits will raise the water level and thus cause more frequent and larger inundations. An annual sediment "inflow" to the lower Mekong could be calculated by estimating the land use pattern at present, in **2010 and 2025**, and by using different erosion rates for different land use. For simplicity it could be assumed a 100% trapping efficiency of sediments upstream of hydropower projects with seasonal storage. Although deforestation is taking place at a high rate, much of the undisturbed forest left is upstream of existing or planned hydropower reservoirs. One result could be that the sediment load to Mekong might be at the highest at present when there are relatively few hydropower reservoirs and the deforestation rate is still high.



Fisheries and Aquatic Biodiversity

The impacts on fisheries and aquatic biodiversity in the mainstream Mekong and Great Lake will for the isolated NT2 impacts and for the 5-year and the 20-year perspectives primarily be a result of the changes in hydrology and the secondary impacts resulting from this (sediment transport, flooded river plains etc.). The development plans and trends do not indicate that basin wide pollution problems will be an important factor in this time perspective.

The hydrological changes in the Mekong, percentage wise, are less dramatic than the flow changes the Nam Kading, Nam Hinboun and Xe Bangfai. It is important to be aware, however, that the extremely important fisheries in the lower Mekong (i.e. the Great Lake and the floodplains in Cambodia) are determined by the flooding of the plains and in particular the lowland forest habitats. The inundated land is rich in nutrients and serves as spawning or feeding grounds for fry and juveniles. A lot of fish is caught on the plains but large amounts follow the receding water back into the Mekong. Without this inundation the Cambodian fisheries would only be reduced compared with today. The average fish production in the Great Lake is according to the latest estimates 235,000 tonnes per year (MRC December 2002).

There seems to be a positive relationship between the magnitude of the annual flood-pulse and the fish production in the Great Lake. For the bag-net fishery in the Great Lake River that connects the Great Lake to the Mekong, the "dry" year catch can be close to half of the catch in a "wet" year

Thus the Mekong fish have adapted themselves to the annual flood-pulse, and have an intimate relationship with it. In the lower Mekong floodplains and the Great Lake the relation to water flow has roughly be described as "the higher the wet season flood, the more fish". Several studies have discussed the relationship between annual variations in Great Lake flood level and the fish catch (Baran et al, 2001, Lieng & van Zalinge, 2002). The studies indicate a strong positive correlation between floods and fish production. Baseline data on fish catch are, however, uncertain and a number of other ecological factors in addition the flood levels, are in play. Thus, the present knowledge does not allow for determination of a definite production figure pr. flooded area. The most productive fish breeding areas on the floodplains and around the Great Lake are reported to be shrub and forest-covered wetlands. These vegetation types are under pressure of being converted into agricultural land, which are less suited as breeding grounds and might contribute to increased pollution problems.

For most of the fish species found in the Cambodian and Vietnamese parts of the catchment, migrations take place within Mekong and its tributaries downstream Khone falls. Some species are able to "climb" Khone falls but the majority of species are blocked at this site. Changes in water flow and water quality in Nam Kading and in Xe Bangfai are therefore not likely to have any significant impact on fisheries in downstream countries.

The hydrological impacts of **Nam Theun 2 alone** are shown in Figure 6. Between Pakhinboun and the mouth of Xe Bangfai there will be a slight reduction in water flow both in the wet and in the dry season. In theory this might be negative for the concentrations of fish that are adapted to survive the dry season in deeper pools of the river. However, the water level reduction will be marginal and no significant impact is foreseen. The potential negative impact will, in the 5-year perspective be more than compensated by planned upstream hydropower developments, which will increase the dry season flow.

For the downstream fisheries the reduction in peak wet season flow is the most important factor. The hydrological calculations have indicated that NT2 will cause a reduction in Great Lake average maximum flood level of about 1%, compared to an annual variation in maximum level of about 2,5–3 m, and thus cause an insignificant reduction in fish production potential.

With all the upstream hydropower projects included in the **5-year perspective**, and the predicted hydrological changes (Table 29) the potential stress to of fish surviving in pools in the Mekong mainstream Pakkading and the outlet of Xe Bangfai will be removed.

The reduced maximum flow will, however, result in an average reduction in the Great Lake maximum annual water level of about 22 cm and thus cause a small negative impact on fish production potential.

In the **20-year perspective** further upstream hydropower development will have resulted in that the average low-flow level have been significantly increased and the wet season flow significantly reduced in the Mekong (Table 29). The changes might have reached levels where they will have negative impacts on the migration and spawning cycles of several fish species. The knowledge of fish biology does not allow, however, for any precise prediction of such impacts on commercially important or endangered aquatic species.

In the Great Lake the reduced maximum flow will result in an average annual reduction in maximum Lake level of about 54 cm, compared to an annual variation in maximum level of about 2,5–3 m, and thus cause a significant reduction in fish production potential.

It is not likely that either the **NT2 alone**, or the **5-year perspective** will cause any significant negative impacts on the aquatic biodiversity in the Mekong zone. There might be small changes in distribution of some species but there is no indication that the species composition will be changed or that vulnerable species will be endangered.

In the **20-year perspective**, however, the situation is more uncertain. The combined impact of the planned projects will cause fundamental changes in the ecology of the Mekong. It is, thus, likely that some species will have their habitat destroyed or their life cycles interrupted. Special concern is related to the plans for building a hydropower plant on the Mekong mainstream in Cambodia (Sambor) and the utilisation of a part of the Mekong at Khone fall (Thakho) in Lao PDR. Both projects have the potential to negatively impact some of the unique and highly endangered aquatic species found in Mekong.

Wetlands

Several wetlands might be impacted by changes in hydrology and sediment transport in the Mekong. The most important of these are the Siphandon Wetlands in Lao PDR upstream of Khone falls and the Ramsar site Stung Treng Wetlands in Cambodia downstream of the falls. These wetlands are passageways for migrating fish and are critical habitats for many fish species, waterfowl and other wetland fauna and flora. The ecological functions and their dependencies of hydrological factors and fluctuations are complex and little understood. Thus in this assessment the assumption has been made that changes in the natural flow conditions will have an overall negative impacts on the present ecological functions and biodiversity.

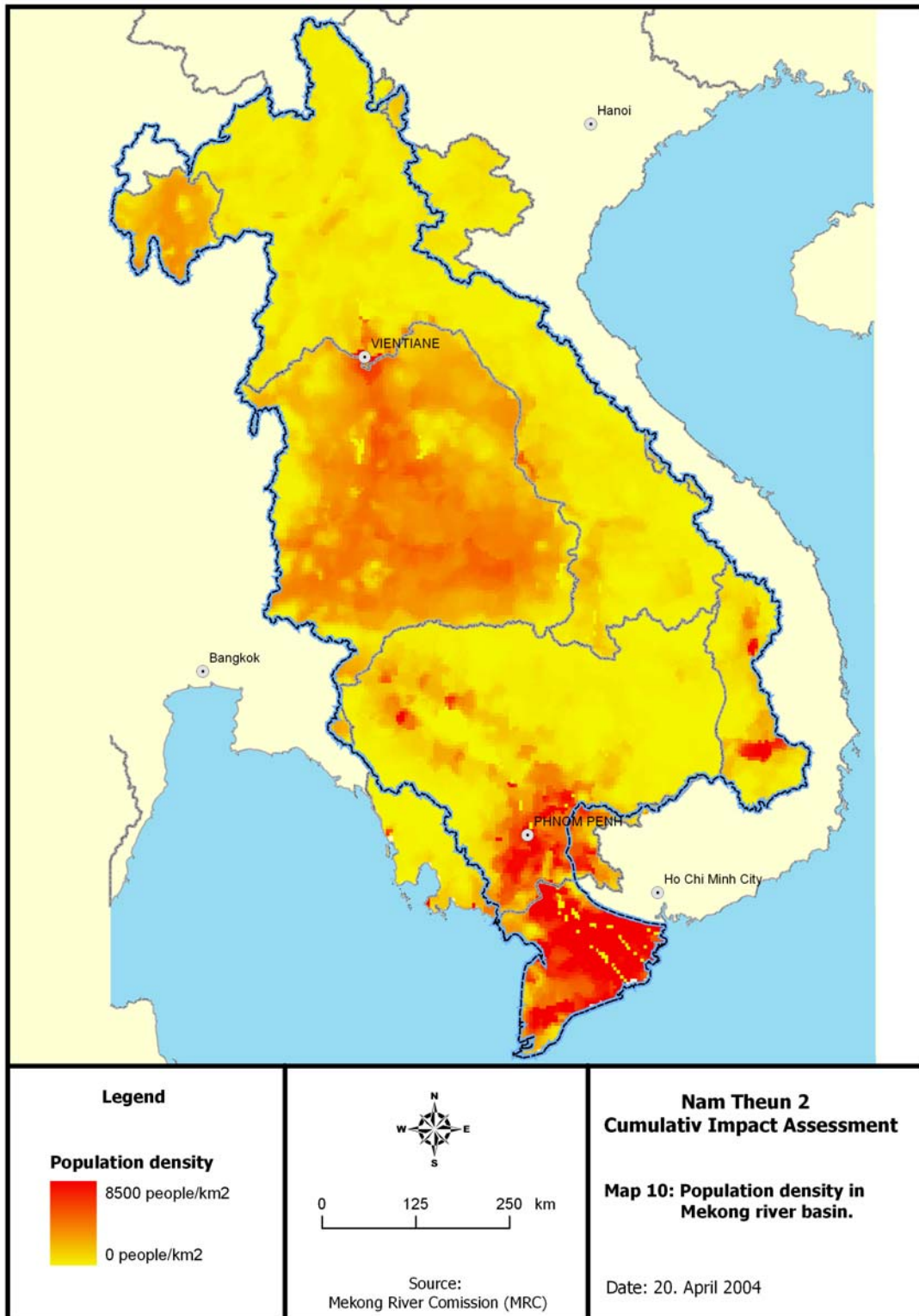
Similar to impact on fish and fish biodiversity, it is likely that the impact on wetlands of **NT2 alone** will be insignificant, and the impacts on wetland will be small in the **5-year** perspective. In the **20-year** perspective, however, more significant negative impacts might be envisaged.

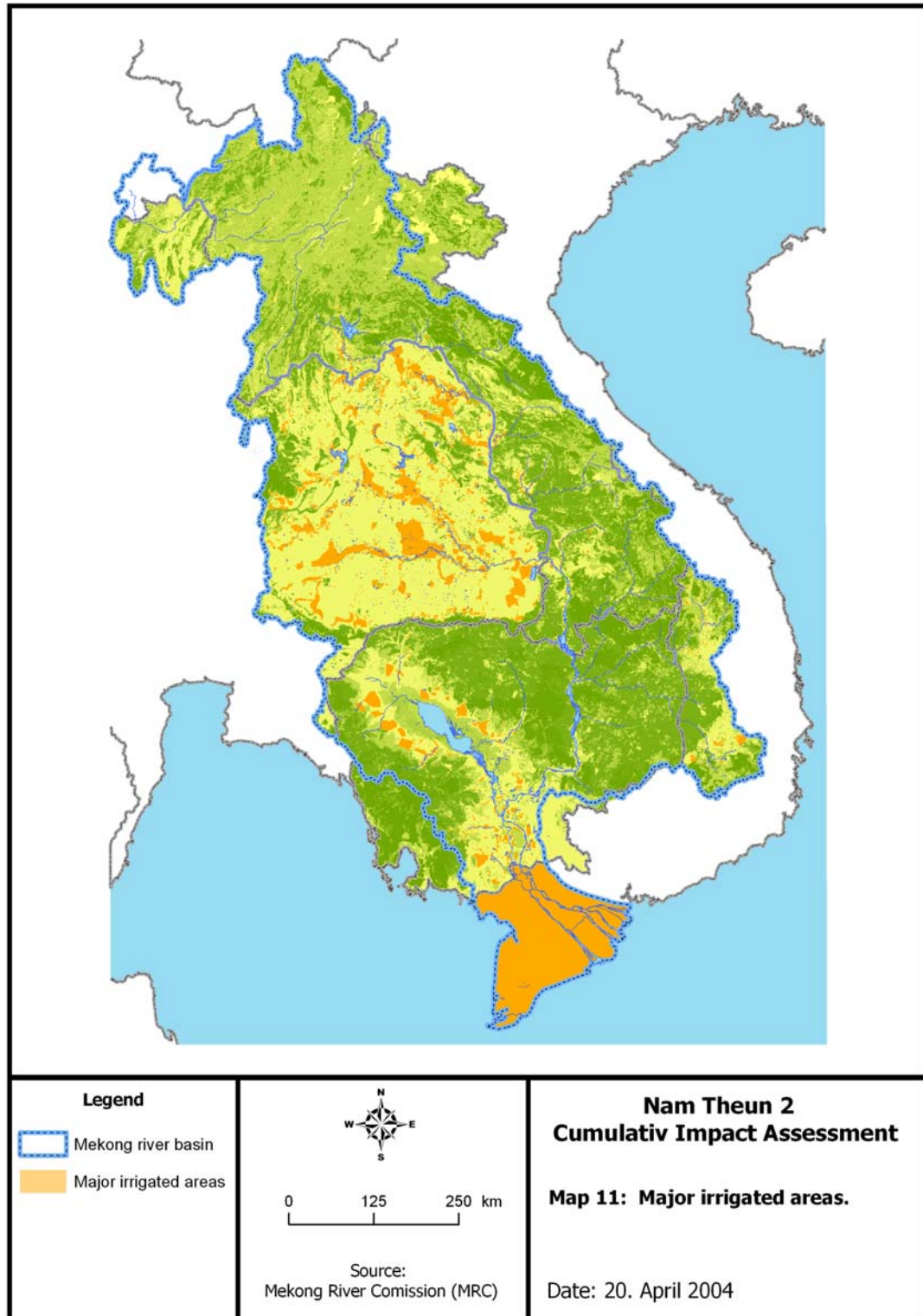
Agriculture

Agriculture in the Lower Mekong Basin is expected to develop rapidly as increasing population's lead to the expansion of agricultural lands and intensified cultivation practices. It is first and foremost Cambodia and Lao PDR that possesses land that can be reclaimed for agricultural production land, while Northeast Thailand and the Mekong Delta have little additional land suitable for cultivation. Development plans for the Delta, however, include increased production and diversification of crops.

The most important water management issues in the Delta area are water shortage and saltwater intrusion in the dry season. These two elements are threatening the agricultural production in the area.

During the early part and end of the dry season the flow in the mainstream Mekong is sufficient to meet the water requirements for irrigation. In the mid part, however (March to May) the highest demand for irrigation water coincides with the minimum Mekong flow.





During the dry season the salt marine water moves upstream along the rivers and channels in the Mekong Delta. The highest salinity is usually observed in April. Currently about 1.7 million ha of the total Vietnamese delta area of about 4 million, is affected by saltwater intrusion. This affects irrigation and domestic water supply and sets a limit to further development of irrigation systems.

As mentioned under the hydrology section, the **NT2** will slightly increase the dry season flow and thus have a beneficial but marginal impact on the water availability for irrigation and reducing salt-water intrusions.

The Pak Kading-Xe Bangfai reach of the Mekong presently has some irrigated areas estimated to be around 4,800 ha in the wet season and 3,700 ha in the dry season. These consist of irrigation schemes that draw water directly from the Mekong and from small tributaries influenced by the flow level in Mekong. The potential for expansion of irrigated areas has been estimated to almost a doubling for both the wet and dry season irrigation. The potential effects on irrigation schemes due to changes in water level are expected to be insignificant in this reach. During the dry season only a 0 to 2 cm lowering of the flow level is foreseen while during the wet season a 23 to 29 cm change is expected.

In the **5-year** perspective the period with negative discharges (water flowing upstream due to high tide and low flow) at Tan Chau will be reduced to 8.4% of the time from 9.5% in the baseline. The positive effect on more water available for irrigation will increase accordingly.

In the **20-year** perspective the Delta will experience a significant reduction of seawater intrusion in the dry season due to the upstream hydropower development. The period with negative discharges at Tan Chau will be reduced to 6.1% of time from 9.5% in the baseline. The positive effect on more water available for irrigation will increase accordingly.

Health

In the **5-year** perspective it is not expected that there will be immediate or cumulative impacts originating in the NT2 Project intervention area that will affect the health situation of people in the Mekong River Basin. Even an increase in the use of pesticides and herbicides, which might cause local health problems in selected communities or sections, will not have any significant impact on humans and aquatic life in the Mekong River Basin at large.

In the **20-year** perspective, however, the combined hydrological changes might reach levels where they might have an impact on water related diseases and on the nutrition situation through its impact on fish production. Reduced flood levels might be negative for fish production but on the other hand, will most likely cause a reduction in the frequency of several water borne diseases.

7.6.3 *Summary of Impacts*

The impacts of **NT2, alone**, on downstream Mekong conditions are as follows:

- Between Pakhinbound and Xe Bangfai outlet there will be a reduction in both dry season (about 2 cm) and wet season (23 –29 cm) water level. The increased pumping cost for dry season irrigation will not be measurable. The reduced wet season level will have a positive impact by reduce flooding of the flood prone and highly developed agricultural land on the Thai side of the river.

- At the Tonle Sap River confluence, the Mekong water levels may be increased by about 2-3 cm in the dry season and reduced by around 3 cm during floods
- The Great Lake responds to the Mekong changes by lowering the maximum water level by between 3 cm compared to an annual variation in maximum level of about 2,5–3 m.
- The construction of the NT2 reservoir will cause only minimal retention of sediments and thus not have any significant impact on Mekong sediment balance.
- The changes in flow pattern will have an insignificant negative impact on floodplain and Tonle Sap fisheries as this is favoured by high wet season water levels.
- The changes in flow pattern will have an insignificant positive impact by damping damaging flood incidents and by increasing dry season water level that will support irrigation and reduce salt intrusion in the Mekong Delta.

Table 30: Summary of the most Important Cumulative Impacts in Mekong River Basin

Mekong River Basin	
(Includes the impacts of planned hydropower developments in all GMS countries)	
5-year scenario	20-year scenario
<p>The dominant factor will be some additional development of hydropower in Yunnan and Lao PDR. The impacts and are calculated to be:</p> <ul style="list-style-type: none"> • Dry season discharge at Savannakhet may increase by 70% corresponding to a water level increase of 65 cm. During floods, the discharges may be reduced by around 10% corresponding to a reduction of water levels by 85 cm. • At Kratie the average annual maximum flow will be reduced from the present baseline of 35,250 m³/s to 33,565 m³/s (5%). • At the Tonle Sap River confluence (Phnom Penh) the water level will be reduced by about 25 cm during floods and increased by about 28 cm in the dry season. The Great Lake responds to the Mekong changes by lowering the average annual maximum level of the lake by 22 cm, compared to an annual variation in maximum level of about 2,5 – 3 m. • The changes in flow pattern will have a small negative impact on floodplain and Great Lake fisheries as these are favoured by high wet season water levels. • The changes in flow pattern will, however, have a small positive impact by damping damaging flood incidents and by the increased dry season water level that will support irrigation and reduce salt intrusion in Mekong Delta. 	<p>The dominant factor will be further development of hydropower in Yunnan and Lao PDR. The impacts and are calculated to be:</p> <ul style="list-style-type: none"> • Dry season discharge at Savannakhet may increase by 135% corresponding to a water level increase of 1.2 m. During floods, the discharges may be reduced by around 20% corresponding to a reduction of water levels by 1.6 m. • At Kratie the average annual maximum flow will be reduced from the present baseline of 35,250 m³/s to 31,020 m³/s (12%). • At the Tonle Sap River confluence (Phnom Penh) the water level will be reduced by about 60 cm during floods and increased by about 70 cm in the dry season. The Great Lake responds to the Mekong changes by lowering the average annual maximum level of the lake by 54 cm, compared to an annual variation in maximum level of about 2,5 – 3 m. • The changes in flow pattern will have a significant negative impact on floodplain and Great Lake fisheries as these are favoured by high wet season water levels. • The changes in flow pattern will, however, have a significant positive impact by damping damaging flood incidents and by the increased dry season water level that will support irrigation and reduce salt intrusion in Mekong Delta.

8 RECOMMENDATIONS FOR MANAGEMENT INTERVENTIONS

8.1 Introduction

In this chapter some of the challenges and obstacles faced in managing the developments that are foreseen as the cumulative impacts in the 5-year and the 20 year perspective are described.

Many of the issues mentioned below have been addressed earlier in studies and plans prepared as part of the NT2 project preparation process. The purpose of this analysis is to highlight some of the most important issues and to see these issues in perspective of the broader development impact scenarios.

8.2 Challenges and Recommendations

8.2.1 *Implementation Capacity and Competence*

Existing Situation

The social and environmental programmes and plans in connection with the NT2 Project will impose demands on government institutions and agencies on all levels charged with the responsibility of implementing them. These plans include the Ethnic Minority Development Plan and the Resettlement Action Plan, which together constitutes the Social Development Plan (SDP), and the Social and Environmental Frameworks Operations Plan (SEMFOP) for the Nakai-Nam Theun NBCA.

The executive part of the resettlement and livelihood restoration activities will be handled by the Resettlement Management Unit (RMU) while implementation will be taken care of by the District Resettlement Working Groups in close cooperation with the Village Resettlement /Compensation Working Groups. The SEMFOP will be implemented by the Nam Theun 2 Water Management and Protection Authority (WMPA), consisting of an executive secretariat under the direction of a board.

Both the RMU and the WMPA will rely heavily on the district staff of both government agencies and mass organisations for the implementation of their mitigation, resettlement and development activities. The staff will be required to work both on a full and part time basis with the RMU and the WMPA for lengthy periods of time, particularly during the construction phase.

A recent project study carried out under the ADB Capacity Building Assistance Project (ADB, 2004) assessed the availability of district staff in relation to the requirements for the implementation of the SDP and the SEMFOP.

As indicated by the results shown in Table 31 the district that is going to face the largest staff deficiencies is Nakai District, which in order to balance out the RMU and WMPA requirements will need an additional 125 staff. The other districts will also face substantially increased demands on their technical and administrative capacity.

Table 31: Estimated Staff Needs of NT2 in Relation to Available District Staff

District	Existing staff	RMU need	WMPA need	Total NT2 need	NT2 need in % of total available staff
Khamkeut	147	22	15	37	25%
Gnommalath	191	28		28	15%
Mahaxai	84	26		26	31%
Nakai	37	90	72	162	438%
NongBok	64	13		13	20%
XeBangfai	19	21		21	111%
Xaibouly	72	18		18	25%

Source: ADB Capacity Building Assistance Project – Phase I

STEAs, together with their provincial offices (STEOs), and the Social and Environmental Management Division (SEMD) of the Department of Electricity, MIH, will play a crucial safeguard and monitoring role in connection with the implementation of the NT2 Project and other hydropower projects in the future. The number of staff and staff qualifications are summarised below.

Table 32: Staffing and Qualification Level of Provincial and Central Agencies

Agency	Total Staff	Education Level	
		University	College
STEAs - Dep. of Environment	19	17	2
EIA Division	5		
SIA Division	2		
STEO - Bolikhamxai	6		
STEO - Khammouane	14	9	5
STEO - Savannakhet	6	1	5
SEMD – Dep. of Electricity, MIH	5	5	

STEAs: Provincial Science, Technology and Environment Office
SEMD: Social and Environmental Management Division

Both the EIA/SIA Divisions of STEAs and the SEMD have been recently established and are presently being built up and trained. In relation to mandates and responsibilities their staffing is relatively limited as is also their funds for equipment, training and travel.

The provincial STEOs, which will be crucial for monitoring and follow up of environmental and social plans in connection with development projects in their province, are also in the process of being built up. Khammouane is the province with the highest number of STEO staff.

Challenges

The implementation of the NT2 will pose challenges to the government and mass organisations on all levels. The most pressing challenge in the short run will be the lack of technical staff to carry out all the assigned tasks in connection with the NT2 environmental and social programmes. As the district where the resettlement takes place, Nakai will face the biggest challenges.

The additional human resource demands created by the NT2 Project will most likely result in a situation where less attention and personnel resources are available for other important tasks and obligations, for instance in connection with other development projects in the area. The planned cement factory in Mahaxai District is an example of such a project that will have to compete with NT2 for district staff resources. In addition to Mahaxai, Gnommalat is the district that probably will be most affected by the “tying-up” of human resources by the NT2.

Recommendations

Given the challenges noted above there is a clear need to plan ahead how to meet staffing and training needs in connection with the implementation of the NT2 Project as well as other development projects the area. Planning should include:

- a more detailed account of the type and number of staff that will be needed;
- an assessment of sources of recruitment and recruitment procedures;
- identification of technical skills that cannot be filled by district and provincial staff;
- an outline of funding sources for the government and estimated budget requirements for the different types of resettlement and development activities.

The issue of funding of resettlement and development activities is crucial and should be resolved as quickly as possible. It will be necessary to review and explore external funding options either as a grant or a loan as scarcity of resources on the part of the GoL is likely to be an obstacle to action. With regard to funding of capacity building and training, donor agencies should be identified and enlisted as soon as possible.

To meet the challenges of properly following up the NT2 and other projects in the area, STEA and SEMD should be strengthened through targeted training and operational support. Given the budget situation of the Government, international donor funding should be sought for the training component. Funding for recurrent operational costs should as a principle be furnished by the Government but to secure that the training is put into practice, a more time limited budget support for travel and administrative costs by development agencies should be considered.

8.2.2 *Integrated Planning*

Existing Situation

Today planning in the Lao Government system is done on a sectoral basis with limited coordination and harmonisation of goals. Coordination is to some degree taking place at province level but is mostly concerned with the budgetary aspects of sectoral plans, not their physical, social and environmental dimensions and implications. Sectoral plans thus tend to be regarded as fulfilling a quantified goal or a service function and not as contributions to an overall development goal. This situation has its background in the tendency to define development in terms of availability of particular services such as road access, access to clean water and houses with electricity etc.

Integrated planning will offer better opportunities to direct resources to the sector where they have the best overall development effect and to avoid unnecessary negative environmental and social impacts.

Over the past years the government system has been going through a process of decentralisation where power and responsibilities are devolved to the province and district levels of government. This includes responsibilities for both strategic and operational planning with strategic planning being done at province level while operational planning is left more to the districts.

Another feature of the current planning situation is the involvement of the private sector. After the market reforms that were introduced from the middle of the 1980s, the private sector has come to play an increasingly important role in planning and determining the development of some sectors. The industrial sector is possibly the sector that has been most influenced by market forces and private investments, while the hydropower has increasingly also seen private sector involvement.

Challenges

There is a need for a more harmonised and integrated development planning process to reduce conflicting planning goals and facilitate resource allocation to each sector according to their importance and contribution to the agreed overall development goals.

With regard to the decentralisation process the challenge is to harmonise and reconcile the need for integrated planning with the process of imparting power to the province and district levels to act independently. The built-in conflicts of decentralisation and integrated planning can be expected to increase and become a challenge in the future as the decentralisation process takes more hold.

Finally, private sector involvement in a number of sectors is most probably going to increase in thus giving market forces more roles in determining future developments. This will reduce the role of government and weaken the position of integrated development planning as various government institutions have practiced it.

Recommendations

With the increased private sector participation in development, GoL's role as a regulator and strategic planner becomes more important. Through strengthening of important planning institutions the Government should seek to promote an integrated development planning framework within which the private sector can be invited to participate.

Institutions that should be considered for strengthening include the 4 agencies under the Prime Ministers office with special responsibilities in integrated planning. These are the Rural Development Committee, the State Planning Committee, the Land Allocation Committee and the Science, Technology and Environment Agency. At provincial level the focus should be on the Provincial State Planning Committee, the Department of Planning and Cooperation, the Provincial Rural Development Committee and the Rural Development Office, while at district level the District Planning Office should be strengthened

In addition to focusing on integrated planning through training and capacity building there is a need to clarify the roles and responsibilities of all the possible ac-

tors. As decentralisation proceeds it would appear most important to strengthen the integrated planning capacity function at province level.

In the future efforts to strengthen integrated planning and environmental and social assessment should constitute a main focus. STEA as the key environmental safeguard agency should be given the responsibility for training other planning institutions in environmental and social safeguard principles and also be given a role in screening and evaluating government development frameworks and plans.

8.2.3 *Management of other NBCAs*

Existing Situation

As mentioned several times in Chapter 7, there is a danger that the improved management regime planned for Nakai-Nam Theun NBCA (SEMFOP) might cause an increased pressure on the values in the other NBCAs in the region. Some initiatives are however underway.

The Wildlife Conservation Society (WCS) are planning to start a 5-year project in Bolikhamxai Province, co-financed by GEF. Provided that the project plans are approved by GEF, this might bring biodiversity conservation in this region an important step forward. The Nam Kading NBCA, Phou Hin Poun NBCA and Nam Chat/Nam Pan PCF will benefit from this project. This project could counteract the otherwise negative trend with regard to biodiversity conservation in this region, at least within the protected areas.

Challenges

The future challenge will be to mobilise resources for the development of management plans and establishing of control apparatus for the protected areas in the region, in particular for the Hin Namno, Phou Hin Poun and Nam Kading NBCAs.

Several plans have been tabled for extension of existing NBCAs and establishing new conservation areas. It will be necessary to assess this in the light of the capacity of the existing management system and the danger of spreading limited resources too thin.

Recommendations

Programmes should be established to increase the competence and capacity of the administrative staff for nature conservation.

A comprehensive and balanced plan for the establishment of new protected areas and NBCAs should be prepared for the Lao PDR. The plan needs to prioritise the areas in question in order to find a realistic level of protection in balance with other users of the areas and in balance with the enforcement and inspection capacity at hand.

In terms of funding the establishment of the Nakai-Nam Theun NBCA and the financing of its management by the Developer through the WMPA sets an important precedence for future funding of NBCA. The possibility of establishing a fund for management and protection of all NBCAs in the country should be considered. One of the main sources for the fund could come from a concession fee levied on all future hydropower development projects in the country, both private and public. The experience with WMPA and its funding from the NT2 Project should therefore be studied and evaluated closely.

8.2.4 *Environmental Assessment*

Existing Situation

The main environmental legislation in Lao PDR is the Environmental Protection Law of 1999, further elaborated by an implementation decree in 2002. A general frame “Regulation on Environmental Assessment in Lao PDR” was issued in 2000.

According to the Environmental Protection Law and the Regulation all line Ministries are required to prepare environmental assessment guidelines for their activities and operations. Only the Department of Electricity of MIH and the Department of Roads of MCTCP have so far responded to this requirement. Both these Departments have now developed their own environmental regulations and set up environmental divisions. These regulations and standards appear to be broadly consistent with state of the art international guidelines and safeguard principles.

Challenges

Implementation of existing environmental regulations and guidelines will to a large extent depend on the resources available in STEA and the environmental divisions in the sector ministries.

The fact that the EIA regulations and guidelines have not yet been developed for a number of project categories where EIA is legally required, is a problem for a balanced assessment of different development initiatives.

Presently the Social and Environmental Division of the Department of Electricity employs only 5 people that have to follow up and implement a relatively demanding and comprehensive set of regulations and guidelines. The Ministry of Transport, Department of Roads, Social and Environmental Division (SED), has seven full-time staff to oversee and monitor social and environmental aspects of roads in the whole country. STEA’s Environmental and Social Assessment Division presently consist only of 7 staff.

Thus, there are several problems linked to the assessment of environmental and social impacts of development projects:

- Lack of regulatory framework for EIA content and processes for several important project categories (forestry, agriculture, industry, mining, etc); and
- insufficient capacity and competence in managing and controlling the EIA preparation and in implementation of its recommendation in MIH and MCTPC and the total lack of such capacity in the other Ministries.

In today’s situation there is a risk that some project categories (roads and hydro-power) get a lot of attention but with limited follow up and that for other, sometimes equally important projects, no assessments are made at all.

A relevant example is the cement factory planned to be built in Mahaxai. Possibly due to lack of specific sector environmental assessment guidelines it appears that an EIA for the project has not been carried out. It is unclear what kind of environmental assessment, if any, will be demanded by the authorities.

Recommendations

STEAs should again encourage the sector Ministries and support their efforts in developing sector specific regulations and guidelines for project categories under their responsibility.

With regard to assessing cumulative effects in the NT2 Project Area an EIA study should be carried out for the planned cement factory planned at Mahaxai.

In addition to preparing guidelines for project specific EIAs there is also a need to take a more strategic view of each sector. By developing “Strategic Impact Assessments” for the most relevant development sectors a better basis for planning and political decision making can be achieved. The Strategic Impact Assessments would provide an up-front broad outline of anticipated impacts of the most important potential projects in the sector and facilitate comparison and prioritisation.

Technical assistance and training should be provided in Environmental Impact Assessment procedure and techniques in existing and new “Environmental Units / Divisions” in the sector ministries.

8.2.5 *Cross-border Cooperation*

Existing Situation

The development in the areas influenced by NT2 are also determined by the development on the Vietnamese side of the border. This influence is already being experienced today and will be further strengthened by improvements to the trans-border road connections and the development of road plans in Vietnam. This development is in particular critical for the future for the Nakai-Nam Theun NBCA and the other NBCAs in the border area and along road 8 and road 12.

Some initiatives for cooperation between the conservation authorities and relevant NGOs in Lao PDR and Vietnam have been taken but seems still to be on an informal level.

Challenges

The future of the protection of biodiversity values of the NBCAs and the establishment of sustainable management systems for these areas is to a great extent dependent on a strong commitment of authorities on both sides of the border to plan and control the activities in the NBCAs. Without the involvement of the Vietnam side the NBCAs in this region run the danger of being seriously degraded.

Recommendations

Bilateral arrangements – preferably legally binding – should be established between Lao PDR and Vietnam for planning, management and control of Nature Protection Areas in the mountain range border. International NGOs active in both countries can facilitate such arrangements but the final responsibility has to be placed on the governmental level.

Joint principles of management and protection needs to be developed and included in operational management plans. The arrangements should in particular focus on curbing illegal logging, hunting and wildlife trade.

8.2.6 *Mekong Basin Planning*

Existing Situation

The Mekong River Commission is the main regional instrument for water related planning in the Lower Mekong Basin. The 1995 Agreement on the Co-operation for the Sustainable Development of the Mekong River provides a legal framework for co-operation that commits the four signatory countries to; “sustainable development, utilisation, conservation and management of the Mekong River Basin for social and economic development” (preamble of the Agreement). Several tasks and objectives mentioned in the agreements are relevant for addressing problems related to cumulative impacts in the Lower Mekong Basin:

- Sustainable development, utilisation, management and conservation of water and related resources of the Mekong River Basin, including irrigation, hydropower, navigation, flood control, fisheries, timber floating, recreation and tourism.
- Joint and/or basin-wide development projects and basin programmes through the formulation of a Basin Development Plan.

The implementation of the elements of the Agreement is facilitated by the MRC through providing a forum for exchange of information and through overall planning and research activities. The project specific planning and implementation is the responsibility of the relevant authorities in the member countries.

The Joint Committee of MRC in 1998 approved several principles relevant for hydropower development. This included the principle that information should be exchanged among the MRC member states as well as the GMS countries; and that state of the art assessment of cumulative environmental impacts and socio-economic aspects should be carried out by MRC in order to promote the most effective use of the natural resources in the Lower Mekong Basin.

An important factor determining the future water regime in the Mekong is the plans for hydropower projects in Yunnan. From the 5-year scenario and the 20-year scenario it is seen that this development will have significant impact on downstream water use and ecology. The People’s Republic of China is at present not a member of MRC and thus not bound to the principles of the Mekong agreement.

Challenges

The main challenge of the MRC is to fill the role of an institution for real case co-ordination between the countries and safeguarding a sustainable use of the water resources in the basin. For hydropower development the initiative has now been taken over by the national authorities and private investors, leaving MRC as a forum for information exchange at a late stage in the process.

It is to be hoped that the results of the Water Utilisation Programme and the Basin Development Plan will provide a basis for more proactive actions in relation to larger development project in the Basin.

Recommendations

Given the fact that neither the People’s Republic of China (Yunnan) nor Myanmar are members of the MRC efforts should be made to strengthen mutual information exchange and cooperation with these upper-basin countries. The strength-

ened cooperation should be done both through a stronger integration of especially Yunnan in the MRC work as well as through the Greater Mekong Sub-region Initiative.

The legal mechanisms of the Mekong Agreement should be strengthened in order to make the Commission an efficient forum for implementation of the principles of fair and equitable use of water resources in the Basin and for solving conflict between the countries.

MRC should be given an active role in managing processes of water related Cumulative Impact Assessments and Strategic Impact Assessments in the region.

8.3 Best Practice Scenario

8.3.1 Introduction

In Chapter 7 the 5-year and 20-year scenarios are indicated for each impact zone. The scenarios are based on the assumption that the proposed safeguard plans and initiatives proposed in connection with the NT2 project are implemented and working according to the intentions. The planned interventions represent, in many respects, much more advanced and comprehensive compensation and mitigation measures than normally found for a hydropower project in the region, and can thus be seen as examples of “best practise”.

In this CIA, however, the “best practise scenario” is based on the implementation of recommendations and initiatives that come **in addition to the NT2 safeguard activities**. Most of these recommendations are related to potential impacts outside the main NT2 project area and to sector developments and projects other than NT2.

8.3.2 “Best Practise Scenario”

Table 33 summarises the recommended mitigation and compensatory activities and initiatives described in section 8.2 and assessments of their impacts in the 5-year and 20-year perspective. The impacts identified in Chapter 7, combined or modified by the assumed results of the recommendations will constitute the “Best Practise Scenarios”.

Table 33: Summary of Best Practise Actions and Scenarios

Action	5-year impact	20-year impact
Establish a plan for staffing and training needs in connection with NT2 and other projects in the area.	Resettlement and livelihood restoration and development appropriately carried out.	Maintenance of adequate livelihoods in the resettlement villages.

Provide training and equip STEA and SEMD with resources needed for monitoring and follow up of NT2 and other projects.	Better quality assurance of the NT2 resettlement social development and resettlement process.	Environmental assessment and safeguarding established as a procedure in connection with development projects
Strengthen the role of Government as regulator through capacity building and establishment of a development framework.	A more balanced development process and a clearer role for the private sector in the development process.	Better government control of the development process.
Strengthen integrated planning institutions at all levels of government through focusing on environmental assessment, capacity building and clarification of roles.	A more balanced development taking into consideration overall development goals and more efficient resource allocation between sectors.	A more effective and sustainable use of available natural and financial resources.
Establish programmes to increase the competence and capacity of the administrative staff for nature conservation.	Gradually improve the control of activities in the NBCAs.	Lessen the pressure otherwise induced by the focus on Nakai –Nam Theun NBCA.
Develop a comprehensive and balanced plan for the establishment of new protected areas and NBCAs	Improved institutionalization of conservation efforts.	Might substantially improve the protection of NBCAs. Allow for a more efficient use of resources for protection of biodiversity.
Explore the possibilities for setting up a fund for NBCA management with contribution from larger development projects (e.g. hydropower development).	Improved protection of NBCA surrounding the Nakai-Nam Theun NBCA.	More resources for management of NBCAs countrywide.
Develop EIA regulations and Environmental and Social Units / Divisions in all relevant ministries.	Secure that impact assessments are made for all project categories.	Better control of development activities and provide for balanced assessment of development projects.
Carry out an EIA for the Mahaxai cement factory.	Better overview of cumulative effects and a better basis for planning of mitigation activities.	Less long terms and lingering environmental and social effects.
Develop Strategic Impact Assessments for the most important and relevant sectors.	Improved basis for planning and prioritization of development projects.	More balanced development with less negative environmental and social ramifications.
Increase the EIA competence and capacity in all sectors both in Central administration and in the Provinces.	More professional handling and control of the EIA processes.	Efficient implementation of mitigation and compensation measures related to development projects.
Establish bilateral legal arrangements between Lao PDR and Vietnam for planning, management and control of Nature Protection Areas.	Provide the basis for better control and protection of Nature Protection Areas.	Significantly improved control of illegal practises and trade in timber and wildlife.

Develop joint principles and plans for management and protection of border biodiversity areas.	Will provide a basis for better management.	Established systems of sustainable use of the most valuable biodiversity areas in the country.
Integrate China and Myanmar more into the MRC and GMS cooperation and initiatives.	Better information exchange.	Might have an influence on the development and operation of Chinese hydro-power project, and consequently on downstream impacts.
Strengthen the legal mechanisms for implementation of the Mekong Agreement.	Will facilitate implementation of the principles for fair and equitable use of water resources and contribute to conflict resolution between countries.	Will improve the processes of consultation regarding downstream impacts of projects. Might lead to modification of project plans and reduce negative impacts.
Give MRC a leading role in water related Cumulative Impact Assessments and Strategic Impact Assessments.	Better upfront awareness of environmental and social impacts related to sector developments in the Mekong Basin.	A more balanced development of water related sectors and less negative environmental and social and impacts.

9 REFERENCES/BIBLIOGRAPHY

- Asian Development Bank, 1995. *Involuntary Resettlement Policy*. ADB, Manila.
- Asian Development Bank, 1998. *Indigenous Peoples' Policy*. ADB, Manila.
- Asian Development Bank, 2000, *Environments in Transition - Cambodia, Lao PDR, Thailand, Vietnam*
- Asian Development Bank, 2003, *Lao Urban Data Book, ADB TA No. 3492-LAO, Small Towns Development Project, Final Report*
- Baran et al, 2001,
- Chape, Stuart, 1996. Biodiversity conservation, Protected areas and the Development Imperative in Lao PDR: Forging the links. IUCN, Vientiane, Lao PDR.
- Committee of Science and Technology. 1993. Study on Lancang River in Yunnan Province, China.
- Dang Nghiem Van, Chu Thai Son and Luu Hung. 2000. *Ethnic Minorities in Vietnam*. The Gioi Publishers, Hanoi.
- Division of Forest Resources Conservation, DoF, 2000, *Fact Sheets for National Biodiversity Conservation Areas in the Lao PDR*
- Government of Lao PDR - Committee for Planning and Cooperation, 2003, *Foreign Aid Report 2001 – 2003*
- Government of Lao PDR - Nam Theun 2 Watershed Management and Protection Authority, 2002, *Social and Environment Management Framework and 1st Operational Plan*
- Government of Lao PDR - Nam Theun 2 Watershed Management and Protection Authority, 2002, *Social and Environment Management Framework and 1st Operational Plan, Folio of Annexures*
- Government of Lao PDR, 2003, *the National Poverty Eradication Programme (NPEP), Background Document*
- IUCN, 2000, *Bolikhambxay Province Environmental Inventory*.
- IUCN, 2000b, *Khammouane Province, A preliminary Environmental Inventory*.
- Lieng & van Zalinge, 2002
- Meritec / Lahmeyer International, 2004, *Power System Development Plan for Lao PDR*.
- Ministry of Agriculture and Forestry / Science, Technology and Environment Agency, 2003, *Biodiversity Country Report Lao PDR*.
- Ministry of Agriculture and Forestry, 2003, *Forestry Strategy to the Year 2002, Second Draft*
- Ministry of Agriculture and Forestry, Department of Irrigation, 2000, *Feasibility of Medium and Large Scale Irrigation Schemes in 7 Large Plains in Lao PDR*
- Ministry of Agriculture and Forestry, Forest Inventory and Planning Centre, 2001, *Forest Inventory and Preliminary Harvesting and Management Considerations, Nam Theun Resettlement Tract, Nakai District and Gnommalat District*
- Ministry of Education, 2000, *The Education Strategic Vision, a Discussion Paper prepared for the Donor Meeting*

Ministry of Health, 2000, *Health Strategy up to the year 2020, a Discussion Paper Prepared for the Donor Round Table Meeting*

MOH Technical Working Group and JICA Study Team, 2001, *Lao Health Master Planning Study, Progress Report 1*

MRCS 2001, *MRC Hydropower Development Strategy*

MRCS 2002, *Basin Development Plan - Inception Report*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Agriculture and Irrigation*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Executive Summary and Sectors*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Fisheries*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Flood Management and Mitigation*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Hydropower.*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Navigation*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Tourism Development*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Watershed Management*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Water Supply (Domestic Water & Sanitation; Industrial Water Use)*

MRCS, 2003, *Lower Mekong Basin: Future Trends in Agricultural Production, discussion paper.*

MRCS, 2003, *MRC Navigation Strategy*

MRCS, 2003, *Basin Development Plan. Water Used for Agriculture in the Lower Mekong Basin*

Norconsult, 2003, *Water Supply and Sanitation Sector Project, Feasibility Study Phase IIb*

NORPLAN, 1997, *Water Management plan for the Nam Theun / Nam Hinboun Lao PDR.*

NTEC 2003, *Environmental Assessment and Management Plan, Main Text, Draft*

NTEC 2003, *Social Development Plan, Volume 1: Ethnic Minority Development Plan*

NTEC 2003, *Social Development Plan, Volume 2: Resettlement Action Plan*

NTEC 2003, *Social Development Plan, Volume 3: Appendices*

NTEC, 2003, *Xe Bangfai Strategy Paper, Draft – Revision C*

Robichaud, W., Marsh, C., Southammakoth, S., Khounthikoummane, S. 2001. Review of the National Protected Area System in Lao PDR. Ministry of Agriculture and Forestry / Dep. Of Forestry / National Agriculture and Forestry Research Institute, Vientiane.

Science, Technology and Environment Agency, 2000. National Environmental Action Plan 2000. Sustained development.

SEATEC and Sinclair Knight, Merz ECI INC. 1997, *Nam Theun 2 Hydroelectric Project - Environmental Assessment and Management Plan (EMAP)*

SIDA and Department of Environment/STEA 2002, *Strengthening environmental Management Project- Evaluation report*

State Planning Committee, National Statistical Centre, 1997, *Results from the Population Census 1995,*

- State Planning Committee, National Statistical Centre, 2002, *Statistical Yearbook 2001*
- UNDP, 2002, *Promoting Ethnic Minority Development. Poverty Task Force Report, UNDP, Hanoi.*
- UNESCAP, 2004, *Key statistics of population and households in Nakhon Phanom, website*
- Vietnam – Laos Cooperation Program on Water Resources Planning, 1999, *Project on Water Resources Development Planning for Kammouan, Final Report*
- Vietnam – Laos Cooperation Program on Water Resources Planning, 1999, *Project on Water Resources Development Planning for Savannakhet, Final Report*
- Vietnam – Laos Cooperation Program on Water Resources Planning, 2000, *Project on Water Resources Development Planning for Bolikhamxay, Final Report*
- Vietnam Business Forum, 2002, *Issue no 12, June 25, 2002, website*
- World Bank, 2003, *Lao PDR at a Glance, website*
- World Bank, 2003, *Lao PDR Economic Monitor, Vientiane Office*
- World Bank/SIDA/Ministry of Foreign Affairs, Government of Finland, 2001, *Lao PDR Production Forestry Policy, Status and Issues for Dialogue, Main Report, Volume 1 and 2*
- Worley International Ltd. and Lahmeyer International, 2000, *Hydropower Development Strategy Study*



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ASSESSEMENT AND NAM THEUN 2 CONTRIBUTIONS



Annex 1: Sector Plans and Development Trends

Prepared by: Jens Laugen and Erik Børset

November 2004

TABLE OF CONTENTS

- 1 INTRODUCTION.....1**
- 2 HYDROPOWER.....1**
 - 2.1 Regional Perspective1
 - 2.1.1 China (Yunnan).....3
 - 2.1.2 Lao PDR4
 - 2.1.3 Thailand4
 - 2.1.4 Cambodia.....4
 - 2.1.5 Myanmar5
 - 2.1.6 Vietnam.....5
 - 2.1.7 Summary of Power Development Plans.....5
 - 2.2 Lao Perspective6
 - 2.2.1 Development Plans and Trends.....6
 - 2.3 Local Perspective.....7
- 3 TRANSPORT8**
 - 3.1 Regional Perspective8
 - 3.2 Lao Perspective9
 - 3.3 Local Perspective.....10
- 4 WATER SUPPLY AND SANITATION..... 12**
 - 4.1 Regional Perspective12
 - 4.2 Lao Perspective13
 - 4.3 Local Perspective.....13
- 5 URBANISATION..... 13**
 - 5.1 Regional Perspective13
 - 5.1.1 Population13
 - 5.1.2 Urbanisation.....15
 - 5.2 Lao Perspective15
 - 5.2.1 Population15
 - 5.2.2 Urbanisation.....15
 - 5.3 Local Perspective.....16
 - 5.3.1 Population16
 - 5.3.2 Urbanisation.....17
- 6 FORESTRY..... 19**
 - 6.1 Regional Perspective19
 - 6.2 Lao Perspective20
 - 6.3 Local Perspective.....21
- 7 INDUSTRY 23**
 - 7.1 Regional Perspective23
 - 7.2 Lao Perspective24
 - 7.3 Local Perspective.....25
- 8 MINING 26**
 - 8.1 Regional Perspective26
 - 8.2 Lao Perspective26

8.3	Local Perspective	27
9	CONSERVATION	28
9.1	Regional Perspective	28
	9.1.1 Biodiversity values	28
	9.1.2 Nature protection.....	28
9.2	Lao Perspective	29
9.3	Local Perspective.....	31
10	POVERTY AND ECONOMIC DEVELOPMENT.....	32
10.1	Regional Perspective	32
10.2	Lao Perspective	33
10.3	Local Perspective.....	33
11	EDUCATION.....	35
	11.1.1 Regional Perspective	35
	11.1.2 National Perspective	35
	11.1.3 Local Perspective.....	35

LIST OF TABLES

Table 1:	Existing Mekong Basin Hydropower projects - Larger than 10MW.	2
Table 2:	Existing and planned projects in Yunnan.....	3
Table 3:	Existing Projects in Thailand within Mekong Basin (EGAT 2004).	4
Table 4:	Planned projects in Cambodia within Mekong Basin.	5
Table 5:	Existing and planned projects in Vietnam within Mekong Basin. (Hydropower Master Plan 2004).	5
Table 6:	Existing and Predicted Active Storage Volume (mill m ³) in the Mekong Basin.....	6
Table 7:	EdL Generation Expansion Plan (2004-2020) for domestic projects and the most promising export projects (PSDP).	7
Table 8:	Population Increase and Water Consumption	12
Table 9:	Mid Level Population Projections, MRC Member Countries.....	14
Table 10:	Population Increase in the Lower Mekong Basin.....	15
Table 11:	Urban Population in the Lower Mekong Basin Countries	15
Table 12:	Population in the Largest Towns in Lao PDR	16
Table 13:	Urban Population in the 3 Project Area Provinces.....	17
Table 14:	Urban and Rural Population in NT2 Influence Area.....	18
Table 15:	Estimated Population Increase in NT2 affected Urban Areas	19
Table 16:	Forest Cover in the Mekong Basin (MRC 1997).....	19
Table 17:	Regional Forest Area and Biomass in Lao PDR, 1996.....	21
Table 18:	Forest Land Area in 3 Provinces.....	22
Table 19:	Logging by Provinces 1998-1999.....	22
Table 20:	Number of industries and handicraft entities (Selected provinces 1998- 1999).....	24

Table 21: Estimated power demand Central 2,1 grid (Meritec/Lahmeyer International, 2004).....	26
Table 22: National Biodiversity Conservation Areas in Lao PDR (DoF 2000).....	30
Table 23: Poverty Incidence by Provinces Surrounding NT2	34
Table 24: Poor Districts in Provinces Surrounding NT2.....	34
Table 25: Education Indicators 2001/2002 – LMB Countries.....	35
Table 26: Education Indicators for Khammouane Province 1998.....	36

1 INTRODUCTION

In the following chapter is a brief review of the present situation, plans and development trends in the relevant sectors.

For the overall regional perspective this study has largely drawn on regional sector overviews recently prepared for the Mekong River Commission Secretariat as background documentation for the Basin Development Plan. The input to these studies has to a great extent been provided by governmental officials and reflects national priorities and plans.

Other sources of information are sector plans and programmes prepared by the relevant sector Ministries and Provinces and by International Funding Institutions and bilateral donors in co-operation with sector Ministries. Even with the official status of these documents, inconsistencies and differences in predictions as well as rather “over-optimistic” assumptions can be observed. To the degree possible the consultant has commented upon these matters and indicated what is seen to be the most realistic development.

The description of the developments in each sector is in most cases structured in three sections:

- The first covers the larger **regional** perspective, which for some issues coincide with the Mekong Basin.
- The second covers the **national Lao PDR** perspective.
- Finally the **local** perspective, which depending on the issue, sometimes will focus on the local river basins and sometimes focus on the 3 provinces directly influenced by the NT2 project.

As will be seen, the relevance and details given for each of these perspectives will differ depending on where its potential impacts will be seen when added to the potential impacts of the NT2 Project. The least developed sections are related to the local or provincial developments. as the time available did not allow for a comprehensive local information collection and consultation process.

2 HYDROPOWER

2.1 Regional Perspective

The total theoretical potential for hydropower production in the Mekong basin is estimated to about 43,000 megawatts (MW).

In the four Lower Mekong countries this potential is estimated to be about 30,000 megawatts (MW). Of this, 13,000 MW has been identified on the Mekong's mainstream. The remainder is found on the tributaries (13,000 MW in Lao PDR, 2,200 MW in Cambodia and 2,000 MW in Vietnam).

There is also considerable hydropower potential on Mekong (Lanchang Jiang) in the Yunnan Province of China. The total hydro potential is estimated to 23,000 MW.

Compared to the huge theoretical potential for hydropower development only a minor part has been developed so far. Only 5 percent (some 1,600 MW) of the Lower Mekong's hydro potential has been developed. All of these projects are on the tributaries. There are great differences between the countries. While Thailand has developed most of its potential on the tributaries, Lao PDR has developed only a few of its many possible projects. Cambodia is yet to construct its first hydropower project within the Mekong basin. Vietnam has prepared plans for a full development of its hydropower potential, and the first in a series of plants has recently been commissioned. China has an ambitious development plan for mainstream projects. Two large run-of-river projects totalling 2,850 MW have already been completed. Existing, larger hydropower projects are presented in Table 1.

Table 1: Existing Mekong Basin Hydropower projects - Larger than 10MW.

Country	Name	Location	Type	Capacity MW	Output GWh/year	Year of completion
China	Man-wan	M	RoR	1,500	7,870	1993
	Da-chao-shan	M	RoR	1,350	5,930	2001
Lao PDR	Nam Ngum	TR	SS	150	900	1971
	Xeset	TR	RoR	45	150	1991
	Theun Hinboun	TR	RoR	210	1,645	1998
	Houay Ho	TR	SS	150	600	1999
	Nam Leuk	TR	SS	60	184	2000
Thailand	Sirindhorn	TR	SS	36	115	1968
	Chulabhorn	TR	SS	15	62	1971
	Ubonratana	TR	SS	25	75	1966
	Pak Mun	TR	RoR	136	462	1997
Vietnam	Dray Ling	TR	RoR	13	70	1995
	Ialy	TR	SS	720	3,642	2000

Source: MRCS 2001, Legend: M = Mainstream, TR = Tributary, SS = Seasonal Storage, RoR = Run-of-River.

A number of plans and studies exist for hydropower development in the Mekong Basin. In particular the Mekong Committee (the forerunner of The Mekong River Commission) was active in investigating the potential of power production in the Basin and in preparing pre-feasibility and feasibility plans for certain projects. The responsibility for planning has over the last 20 years been assumed by the countries themselves. Also the economic and technical development and the increasingly stronger environmental and social concerns have made many of the old schemes obsolete. This is particularly true for the cascades of mainstream power plants planned for Lao PDR.

Each of the Mekong countries have over the last decades prepared a whole series of hydropower master plans and hydropower development strategies. Many projects have been studied to the level of prefeasibility and even feasibility level. The technical, economic, and environmental options and conditions are, however, constantly changing and thus the feasibility of the projects. In addition the increasingly stronger element of private sector investment and initiative has made it difficult to establish realistic national programmes for project sequencing and implementation.

2.1.1 China (Yunnan)

Chinese authorities have so far planned and implemented their projects without formal consultation with the downstream countries. It appears that no EIAs have been prepared to cover the transboundary impacts of the planned developments. Thailand has, however, indirectly accepted these mainstream plans by signing an MOU for purchasing 3000 MW from China (Yunnan) by year 2017.

As noted above two hydropower plants already exist on the mainstream of the Upper Mekong. According to available information no new power plants will commence operation before 2010 in China. However, construction has started on one of the two largest reservoir projects, the Xiaowan HPP, with an expected date of commercial operation just after 2010. In the period 2010 to 2025, five large new plants are assumed to start operation including the 5500 MW Nuozhadu HPP, see Table 2.

Table 2. Existing and planned projects in Yunnan

No.	Project	Year of commissioning	Installed capacity (MW)	Active storage (mill. m ³)
1	Manwan	1993-96	1500	257
2	Dachaoshan	2001-2004	1350	367
3	Xiaowan	2010-14	4200	9900
4	Gonguoqiao	2012	750	120
5	Jinghong	2013	1500	249
6	Nuozhadu	2014	5500	12300
7	Mengsong	Before 2025	600	-
8	Ganlanba	Before 2025	150	-

2.1.2 Lao PDR

A number of potential hydropower projects on mainstream Mekong in Lao PDR have been identified. Except for a small run-of-river project (Phapheng), which will utilise a minor part of the water flow in the Khone Falls, none of these are included in current development plans. Hydropower Development Plans for Lao PDR are described in more detail under Lao Perspective.

2.1.3 Thailand

Thailand has no new major hydropower plants in its Power Development Programme (PDP) except for an extension of the capacity of the pumped storage project now under construction at Lam Takhong and a new pumped storage plant at Kiridharn (outside the Mekong Basin). Opposition against new hydropower projects in Thailand is strong, and, because of this, mainstream projects along the Lao/Thai stretch of the Mekong are not a realistic option. However, some large multipurpose reservoirs have been established over the last 40 years in the Thai part of the Mekong Basin (Table 3).

Table 3. Existing Projects in Thailand within Mekong Basin (EGAT 2004).

No. ¹	Project ²	Year of commissioning	Installed capacity (MW)	Irrigation area (Ha)	Active storage (mill. m ³)
32	Nam Pung	1965	6	32000	122
33	Ubol Ratana	1966	25	40700	1695
34	Lam Phra	1967		10097	145
35	Nam Pao	1971		50416	1260
36	Sirindhorn	1971	36	24000	1191
37	Nam Oon	1973		29728	475
38	Huai Luang	1984		12800	113
39	Chulabhorn	1972	40	9600	145
40	Lam Takhong	2002	500	22000	320 / 10

¹ Numbers in this table corresponds to numbers in Map 3

² Run-of-river projects and small reservoirs are not included.

Pak Mun and Huai Kum are not included in the estimates on future water flow in Mekong since Pak Mun is a run-of-river project and Huai Kum has a small active storage.

2.1.4 Cambodia

The present few and small hydropower plants in operation in Cambodia are all located outside the Mekong basin. Some project alternatives on the Mekong and Mekong tributaries have been identified. However, it is uncertain if any of these projects are going to be constructed in the near future. The present alternatives have a low internal rate of return. Establishment of upstream reservoirs in Vietnam would however be beneficial for the projects in Cambodia. The original plans of the listed projects were controversial due to large shallow reservoirs requiring a substantial relocation of people. However, more recent studies (Halcrow, 1998) have identified new locations of dams with smaller reservoirs.

Table 4. Planned projects in Cambodia within Mekong Basin.

No.	Project name	Year of commissioning	Installed capacity (MW)	Active storage (Mill. m ³)
55	Lower Se San 2D	Before 2025	185	Not available
56	Lower Se San 2U	Before 2025	153	Not available
57	Lower Sre Pok 2	Before 2025	205	Not available

At this stage no priority or time schedule for implementation are available for these projects. In addition to the seasonal storage projects, Sambor, a 465 MW run-of-river project on the Mekong main stream is included in the Cambodian Power Development Plan. All the potential projects have in common that they are too large to be developed for domestic supply alone. If developed, they will be built for export to southern Vietnam or Thailand, which have large power deficits.

2.1.5 Myanmar

No hydropower projects are expected to be constructed within the Mekong river basin in the next 20 years.

2.1.6 Vietnam

A hydropower master plan is under preparation for Vietnam. Preliminary data from this study has been included here in addition to data from the “Se Kong – Se San and Nam Theun River Basins Hydropower Study” by Halcrow (1999). The projects are found on the major tributaries of Mekong, the Se San and Sre Pok rivers. The projects are listed in Table 5.

Table 5. Existing and planned projects in Vietnam within Mekong Basin. (Hydropower Master Plan 2004).

No.	Project	Year of commissioning	Installed capacity (MW)	Active storage (Mill. m ³)
43	Yali	1999	720	779
44	U. Kontum	Before 2025	220	123
45	Pleikrong	Before 2025	110	1022
46	Se San 4	Before 2025	330	470
47	D. Xuyen	Before 2025	100	484
48	Ban Tou Srah	Before 2025	84	483

¹ Run-of-river projects and small reservoirs are not included.

Existing Dray Ling is a run-of-river and the planned projects Se San 3 (273 MW), Se San 3A (100 MW), Boun Koup (280 MW), Srepok 3 (195 MW) and Srepok 4 (33 MW) all have small active storage.

2.1.7 Summary of Power Development Plans

The sum of current active storage and the expected 2010 and 2025 situation total for all countries are presented in Table 6.

Table 6. Existing and Predicted Active Storage Volume (mill m³) in the Mekong Basin.

	China	Lao PDR	Thailand	Cambodia	Vietnam	Total	NT2-portion
2004	624	5,194	5,529	N/A	888	12,235	-
2010	10,524	12,949	5,529	N/A	921	29,923	12%
2025	23,193	22,608	5,529	N/A	3,589	54,919	6%

The Nam Theun 2 project with 3510 mill m³ of active storage will account for a larger portion of the total active storage in Mekong in 2010 (12%) than in 2025 (6%). The average discharge into the Mekong at the outlet in Vietnam is assumed to be 14,500 m³/s or 460,000 mill.m³ per year. Hence, the total reservoir regulation coefficient would be 0.12 in 2025 calculated at the Mekong outlet. The contribution of NT2 to this will in 2025 be 0.008.

The seasonal variation in flow would be reduced directly in relation to the upstream regulation coefficient. For example, in the Mekong at the border between China and Lao PDR, the variation in seasonal flow, in %, would be drastically reduced, almost eliminating the seasonal difference. The same would happen in the larger tributaries of the Mekong, Nam Ngum, Nam Theun and Se Kong-Se San, whereas the Mekong itself in its downstream reaches would still have a distinct difference between dry season and wet season flow.

2.2 Lao Perspective

2.2.1 Development Plans and Trends

The Power Sector Policy Statement of the Lao PDR government includes, among others, the following priorities:

- Maintain and expand an affordable, reliable and sustainable electricity supply in Lao PDR to promote economic and social development
- Promote power generation for export to provide revenues for meeting GoL development objectives
- A stated target of the policy is to supply electricity to 90% of the population by 2020

A number of strategic plans for power development have been proposed over the years. Efforts have been made to find the optimal sequence of hydropower and transmission line developments, both for the domestic market and for export markets. In recent studies, issues such as environmental standards and greenhouse emissions have been important elements in the prioritisation process together with traditional focus on production and transmission costs.

In the Power System Development Plan, PSDP (Meritec and Lahmeyer, 2004) a long list of about 30 projects, including both project for domestic consumption and for export, has recently been studied and prioritised. The PSDP is based on a least cost expansion priority and partly adjusted to the domestic demand (size of project). Another priority list for hydropower development is found in the Electricité du Lao (EdL) Generation Expansion Plan 2005–2020. Combining the

two priority lists by one arrives at a list of 17 seasonal storage projects that are most likely to be built in the within the time period 2004-2020.

Table 7. EdL Generation Expansion Plan (2004-2020) for domestic projects and the most promising export projects (PSDP).

No.	Project	Year of commissioning	Installed capacity (MW)	Active storage (Mill. m ³)
1	Nam Ngum 1	1972-78 (export)	150	4714
2	Huoay Ho	1999 (domestic.)	150	480
3	Nam Leuk	2000 (domestic.)	60	123
4	Nam Lik	2007 (domestic.)	100	826
5	Nam Theun 2	2009 (export)	1074	3510
6	Theun Hinboun Ext.	2009 (domestic.)	105	2870
7	Xepon	2008 (domestic.)	74	361
8	Nam Ngum 3E	2020 (export)	580	983
9	Nam Ngum 2B	2022 (export)	183	150
10	Nam Ngum 5	2012 (domestic)	90	252
11	Nam Ngum 4A	2015 (domestic.)	55	337
12	Nam Bak 2B	2018 (domestic.)	116	119
13	Xe Kaman 3	2011 (export)	250	108
14	Xe Kaman 1	2014 (export)	468	3340
15	Xe Kong 5	2017 (export)	248	2210
16	Nam Kong 3	2016 (domestic.)	25	299
17	Xe Xou	2020 (domestic.)	59	1710

Run-of-river projects and small reservoirs are not included.

In addition to the hydropower development plans described above, the Hydropower Development Strategy Study (Lahmayer/Worley, 2000) describes and ranks around 50 different projects and project alternatives. The actual development sequence will depend on a number of factors, which will not only be purely economic but involve political, environmental and social considerations.

2.3 Local Perspective

As seen from Table 7 the extension of the capacity of Theun-Hinboun by 105 MW is foreseen to be finished in 2009. The construction of NT2 would accelerate the plans for NT3, since NT3 would compensate for the loss of production at the Theun Hinboun caused by the operation of NT2. The economical benefit of NT3 would increase after inauguration of NT2.

The plan is to extend Theun Hinboun by one unit, i.e. a 50% increase in installed capacity. In addition to this, the present THB Extension project consists of a dam equal to the dam proposed for NT3 (but without the power plant). Some alternatives of Theun Hinboun Extension have been evaluated in the PSDP and the conclusion is that the most viable project is an extension of THB by one unit and construction of Nam Theun 3 dam without the large power plant at the foot of the dam.

Apart from Theun Hinboun Extension there is no hydropower development expected before 2025 that might influence the hydrology of Xe Bangfai and Nam Theun – Nam Kading. Although presently being studied by a potential Developer Nam Theun 1 is not considered to be a realistic and viable alternative.

3 TRANSPORT

3.1 Regional Perspective

The 1997 MRC Diagnostic Study describes status and development trends for roads, railways, inland waterways, and air transport. The conclusions are summarized in the following.

Except for the Mekong Delta and the Tonle Sap area where water transport is predominant, roads are the main arteries of transport. The standard and density of the roads are, however, in many places inadequate. Cross border road links are few, and the ones that are of a decent standard (road linking Phnom Penh with Ho Chi Minh City and the one linking Nong Khai with Vientiane) are very important to regional trade.

Within the Lower Mekong, waterways transport is important both for small-scale transport in tributaries and channels and for heavy-duty transport. Phnom Penh can be reached by vessels up to 2,000-3,000 DWT via either the Mekong or the Bassac. The Mekong stretch between the Yunnan border and Savannakhet (Lao PDR) serves as a navigable waterway. The size of vessels is, however, restricted and dependent on the season, because of several stretches of obstacles and lack of markings.

Railway transportation plays a modest role in the region. The railway system is best developed in Thailand, and also found in Vietnam and Cambodia. Lao PDR presently has no railway.

ADB has initiated plans for development of the regional road network as part of their Greater Mekong Co-operation initiative. The priority road corridors are:

- R1: Bangkok - Phnom Penh - Ho Chi Minh City - Vung Tao, which is nearly finished.
- R2: The Thailand – Lao PDR - Vietnam (East-West Corridor), which is also close to completion
- R3: Chiang Rai – Kunming (Northern Corridor), where construction is about to start.

Potential for upgrading of waterways has been identified by MRCS along the Lao PDR-Myanmar border and between Vientiane and Savannakhet. The upgrading might include some hydraulic works for improving the navigable channel. The reach around the Khone Falls (near the Lao PDR-Cambodia border) is not passable and blocks the continuity of the waterway. Establishing the required system of channels, locks and sluices for negotiating this reach is not considered economically feasible.

The MRC Strategy on navigation is however, not specific about larger dredging and hydraulic works along the Mekong. Its focus is on the removal of the non-physical obstacles to navigation and on improving the safety and possibility for

low flow and night-time navigation by better marking and other navigation measures.

Plans exist for a rail link between Nong Khai (Thailand) and Vientiane; between Thailand and Yunnan; and one for connecting Thailand, Cambodia and Vietnam. The Nong Khai–Vientiane connection now seems to be proceeding with Thai and French funding.

The development of transport links will have a major impact on the development of the region. This includes: new opportunities for economic development, new urbanisation patterns, new location preferences for industries, better access to markets for agriculture and fish products, new opportunities for tourism, etc. However, it might also induce negative impacts like increased pressure on natural resources and biodiversity, human trafficking, spread of HIV/AIDS, threats to the lifestyle of ethnic minorities, etc. There might be both local and cross-border effects.

3.2 Lao Perspective

In the context of poverty reduction and social and economic development, transportation is regarded as a key factor. Today a major share of government funds is channelled into the transport sector while it receives around a quarter of the total overseas development assistance. Particular emphasis has been put on improving road links between the major towns in Lao PDR. Paved roads, in largely good condition, now connect Vientiane with Savannakhet and Pakse to the south and Luang Prabang to the north. Still, in spite of these improvements the transport sector, and in particular the road sector, remains largely underdeveloped in terms of good all-weather rural roads. Insufficient resources to maintain roads once they have been constructed or upgraded add to the problem of poor road standards throughout the country.

The entire road network in the country includes a little more than 7,000 km of national roads, around 9,000 km of provincial roads and roughly 6,600 km of district roads. Another 9,900 km is classified as community/access roads. In terms of length only a little more than half of the national roads were paved in 2002 while the percentage for provincial and district/community roads were less than three percent. Gravel and earth roads account for the remainder of the road network.

The Ministry of Communication, Transport, Post and Construction (MCTPC) is responsible for planning and management of the road network but is increasingly delegating responsibilities to the provincial departments (DCTPC).

Compared to its neighbours Lao PDR has a low road density per square km. The usage of the roads are still considered as light with average daily traffic (ADT) for national roads varying between 250 and 500 vehicles and less than 50 on secondary roads. However, traffic on Route 13 is substantially higher being the main north-south trunk road in the country. A traffic survey carried out by MCTPC in 2000, recorded ADTs from around 700 to 1000 on different sections north and south of Thakhek.

Registered vehicles in the country amount to around 38,000– 39,000 cars and pickups, 14,000 heavy trucks and buses and some 168,000 motorcycles. By far the highest concentration of registered vehicles is found in and around Vientiane. Annually the number of registered vehicles increases with around 17 percent.

The Government regards improvement of the road system as a key to improved national and regional integration and thereby economic growth and poverty reduction. After rehabilitation of the main arterial roads the next priority will be to strengthen the connections between provincial and district centres. This will help bring the benefits of the arterial road network improvements to rural population that presently have no road access.

The Governments 15-year strategy for the road sector includes the following measures:

- institutional capacity to plan and manage the road sector
- prioritizing of the all-weather road network maintenance and replacement of donor funding with domestic funding
- road-use regulations to prevent deterioration of road conditions from overweight vehicles
- safeguarding of environmental and social impacts through environmental mitigation measures and proper resettlement and compensation
- implementation of road safety measures and establishment of a high level National Road safety Council
- increasing private sector participation and strengthening of the domestic contracting industry
- community participation in planning construction and maintenance of district and rural roads.

The high level of investments in the transportation sector is foreseen to continue in the years to come. From 1996 to 2000 56% was allocated to the transport sector, equivalent to about 7% of the GDP. The present relative imbalance between capital and recurrent expenditures for maintenance is also expected to continue. Presently the capital investments spent for upgrading or construction of roads constitutes around 85% of the transportation budget.

3.3 Local Perspective

Branching off from Route 13 roads running east-west traverse and encircle the NT2 Project area. These roads will constitute factors that influence and drive social and economical developments in the NT2 Project area and beyond, adding to those created by NT2 . Road improvement projects are in the process of being implemented or have been planned for the most important of these roads.

In Savannakhet the ADB supported East-West Corridor Project (Route 9) is nearing completion. The 2000 traffic survey recorded ADT figures around 700 on the section near the border to Vietnam. The improvement will substantially increase the movement of goods and people through the province. However, Route 9 is located some 100-130 km south of the NT2 Project influence area and will as such only have a peripheral effect on developments there.

The East-West Corridor Project also includes the construction of a bridge connection between Mukdahan on the Thai side of the Mekong and Savannakhet on the Lao side. The bridge is planned to be completed by 2006, that is, during the early construction phase of the NT2 Project. In relation to cumulative effects the bridge will probably be more significant than the improvement of Route 9 as it will create a conduit for cross border trade and transport that is likely to influence economic development in the NT2 Project influence area.

In Khammouane, Route 12 from Mahaxai to the Vietnamese border is being upgraded, financed by GoL. It is due to be finished in November 2004. The section between Gnommalat and the Vietnamese border has an ADT of around 300 according to the 2000 MCTPC traffic survey. Between Gnommalat and Thakek the traffic was found to be lighter with an ADT of around 100.

The upgrading of the provincial road from Mahaxai to Boualapha District (46 km) is just finished with support from SIDA. It is expected that SIDA will continue its support for community and district roads in Khammouane.

According to information obtained at the district level a new road from Gnommalath into the Phu Hin Poun NBCA is being constructed as a part of an initiative to develop ecotourism in the area. Information on the exact location of this road was not obtained.

Route 8B starting at the junction with Route 12 and traversing the NT2 Project area and the Nakai Plateau was recorded to have a considerable traffic load with an ADT of more than 300 in 2000. As the ADT figures for Route 12 indicates most of this traffic probably went to Vietnam.

In Bolikhamxai, the most important road in the NT2 context is Route 8 that runs from Vieng Kham on Route 13 through the important district town of Lak Xao and on to the Lao-Vietnamese border. The road will be surfaced for all its length. According to plans the upgrading will be finished towards the end of 2005. As a part of the feasibility study for the upgrading of the road a traffic survey was carried out in 1998. The traffic was counted at 3 stations, one located at Viengkham village, close to Road No. 13, one at the bridge across the Nam Theun at Ban Tha Heua, and one Ban Phon Men between Lak Xao and the Vietnamese border. The recorded ADTs were 169 at Viengkham, 181 at Ban Tha heua and 193 at Ban Phon Men.

The NT2 project will improve and realign Road No. 8b that runs from the junction on Road 12, through Gnommalat and across the Nakai Plateau to the Nakai dam site. On the section of between the dam site and the junction with Route 8 north of Lao Xao some improvements are likely to be made by the NT2 Project but it is not known to which standard it will be rehabilitated.

Little is known of transport initiatives in long-term perspective. It is expected, however, that this area will provide more and more important corridors for transport of goods and people between Thailand, Lao PDR and Vietnam. This will lead to development of infrastructure and service facilities related to transport in the three provinces and in the districts on the Thai and Vietnamese side of the border.

Concerning air traffic the Integrated Regional Development Plan for the Savannakhet and Khammouan Region (JICA/CPC 2001) proposes to extend the runway and upgrade Savannakhet Airport to international status, as tourism and economic activity in connection with the special economic zone should create a higher demand for air travel. It also proposes that passengers from Mukdahan in the future should utilize the airport and fly to Bangkok from Savannakhet by establishing a special in-migration control arrangement. If this proposal is pursued, it is unlikely that it will be realised until some time after 2010. The annual passenger demand for the Savannakhet-Bangkok route is forecasted to be around 39,000 in 2012 and 63,000 in 2017

Thakhek is among the alternative locations for a future Mekong bridge after the construction of the second friendship bridge at Savannakhet is finished in 2006. The Thai authorities have already indicated interest in a Nakhon Phanom-Thakhek bridge, and it is likely that it will be realised within the time period 2010-2020.

4 WATER SUPPLY AND SANITATION

4.1 Regional Perspective

Reported per capita use and demand of water for domestic purposes varies between the countries and between different studies. Demand studies have used assumptions of up to 100 m³ per capita per year, which sounds very high in countries where a large part of the population lives in rural areas with underdeveloped infrastructure. Also the population growth figures for the individual countries vary, which also results in different scenarios for future water demand.

Table 8 shows estimated population and domestic water demand in the Lower Mekong Basin by 2025. The table is based on figures from documents produced for the MRC Basin Development Plan and Water Utilization Programme.

Population growth rates in the Lower Mekong Basin are expected to decline in the future, mainly because of general economic growth and family planning.

Table 8: Population Increase and Water Consumption

Country	Population 2000	Growth rate %	Population 2025	Demand per capita m ³ /year	Total demand 2025 mill m ³
Cambodia	9,800,000	2.3	17,303,000	12	208
Lao PDR	4,905,000	2.6	9,318,000	20	186
Thailand	23,130,000	1.0	29,663,000	24	712
Vietnam	16,920,000	1.4	23,952,000	42	1,006
Total	54,744,000		80,235,000		2,112

Source population figures: MRC-BDP Regional Sector Overview 2002

Source water demand estimates: MRC Water Utilization Programme, 2002

The estimates show that the population may reach 80 million people by 2025 corresponding to a water demand of around 2,100 million m³. This translates to an average loss of flow of about 70 m³/s in the Mekong Delta. The need for more water can be counteracted to some extent by improvements in efficiency of supply and leakage reduction in the distribution network. Appropriate pricing of water is also an important countermeasure against excessive use and wastage. Water demands reported per capita use and demand of water for domestic purposes varies between the countries and between different studies.

In Cambodia and Lao PDR, the major cities and towns are close to the Mekong and the main obstacle to supply capacity is lack of treatment plants and distribution network. In Thailand and Vietnam some urban areas rely on groundwater and the demand may be higher than available resources. Supply in the dry season is already a problem.

4.2 Lao Perspective

By 2000 it was estimated that 50% of the population had access to either piped water or water from a protected well. This was an increase from 39% in 1990. Over recent years the sewerage system in Vientiane has been improved by large infrastructure works, mostly in connection with the improvement of the road network in the capital. In terms of piped potable water supply, existing infrastructure covered around 456,000 people or about 54 percent of the urban population by the year 2000. Through the ongoing ADB-funded Water Supply and Sanitation Sector Project, (Phase 1), another 53,000 people will be given piped water access by 2010. Phase 2 of the project is expected to add another 70,000-80,000 people by 2015 with 14-15 towns to be covered. Most of the water sources for the towns will be rivers (including the Mekong) and reservoirs as to date only two of the finished schemes rely on groundwater resources.

In addition to the ADB, a number of international agencies and funding organisations are engaged in development of the water and sanitation sector in the country. These include the Swedish Development Agency (SIDA), the French Development Agency (ADF) and all of the agencies and organisations that are engaged in integrated rural development projects where improved water supply is one of the components.

4.3 Local Perspective

Under the ADB Water Supply and Sanitation Sector Project there are plans to build two water supply schemes in Bolikhamxai and Khammouane. One is in Nongbok District, which is situated in the lower Xe Bangfai basin, and thus falls within the direct impact zone of the NT2 Project. The other is Lak Xao to the north of the NT2 Project area. At Nongbok, the Xe Bangfai will be used as the source for the planned water supply scheme, and by 2010 an average consumption of 17 litres per second is expected.

For Lak Xao the feasibility study is yet to be done and it has thus not been decided whether river water or ground water will be used. However, given current preferences for technical solutions among the government agencies responsible for water supply, it is most probable that surface water from a nearby river, possibly the Nam Phao, will be chosen.

5 URBANISATION

5.1 Regional Perspective

5.1.1 Population

Population pressure in the Mekong River Basin is not very high when compared to other large river basins in Asia. It is, however, at the moment growing relatively rapidly. Over the decade between 1990 and 2000 population growth rates were 4.1% for Cambodia, 3.1% for Laos, 1.2% for Thailand and 1.8 for Vietnam (UNFPA website, 2004) The high rate for Cambodia reflects the return of more than 300,000 refugees in the early 1990's. Present growth rates in Lower Mekong Basin are more moderate and expected to decline further in the future as economic growth, urbanisation and family planning programmes start to influence fertility and birth rates.

Population development is largely determined by 2 factors, death and birth rates. As death rates starts to fall due to improved medical services and water supply and sanitation they are not immediately followed by a decline in the birth rates. Normally birth rates remains high at least a decade and usually longer before they start to drop and approach the level of the death rates. This time lag is normally referred to as the demographic transition. The countries in the LMB are at different stages of the demographic transition period with Vietnam and Thailand nearing or reaching the end and Laos and Cambodia still in the middle of it. The strongest population growth is thus expected in these two countries with present growth rates of 2.6 for Cambodia and 2.8 for Laos (ADB website, 2004). UN projections for all of the MRC member countries are shown in Table 9.

Table 9: Mid Level Population Projections, MRC Member Countries

Year/Period	Cambodia	Lao PDR	Thailand	Vietnam
2010	16612	6,592	66,946	89,128
2020	20,197	7,967	71,913	100,079
2030	23,555	9,282	75,424	108,374
2040	26,748	10,477	77,153	114,253
2050	29,567	11,448	77,079	117,693

Source: UN Population Division website,

Concerning population in the Lower Mekong Basin itself estimates done by the Mekong River Commission shows that it was around 55 million by the year 2000 (MRCS 2002). Growth rates for the future population in the respective countries have also been predicted by the Commission (MRC, 2003). These reflect the different demographic transition stages of the countries in the LMB with Cambodia and Lao PDR retaining high growth rates well into the next decades. It should be noted, though, that present population growth estimates varies from one statistical source to another. In the case of Lao PDR, for instance, the World Bank puts the annual growth rate in 2002 to 2.4, which accords with UNFPA's figure of 2.38, while the Asian Development Bank estimates it to be 2.8. MRC's estimated figure bases itself on last decades (1990-2000) rate of 3.1% and thus accords more with ADB's estimate.

By using MRC's figures and estimates plus assigning an average growth rate slightly lower than today's rates, country-wise predictions on the size of the populations in the Lower Mekong Basin for 2025 can be made. It should be noted that the figures shown in Table 10 at best only can be rough estimates as the actual growth rates will change dynamically as time passes, possibly deviating significantly from the average rates which underlies the estimates.

Table 10 Population Increase in the Lower Mekong Basin

Country	Population ¹	Predicted growth rate ²	Population in 2025	Increase
Cambodia (1998)	9,800,000	2,3	17,303,000	77%
Lao PDR (2000)	4,905,000	2,6	9,318,000	89%
Thailand (2000)	23,130,000	1,0	29,663,000	28%
Vietnam ("2000)	16,920,000	1,4	23,952,000	41%
<i>Total</i>	<i>54,744,000</i>		<i>80,235,000</i>	<i>47%</i>

1. Source: MRC-BDP Regional Sector Overview: Domestic Water & Sanitation; Industrial Water Use, 2002

2. Source: MRC, State of the Basin Report 2003

5.1.2 Urbanisation

Urbanisation is linked to economic growth and may contribute positively to poverty reduction in a country. However, uncontrolled urbanisation and economic growth often create a poor underclass of people who migrate to urban areas in search of jobs and a better life.

Urban areas in the basin will continue to be at the centre of economic growth. Those areas with large productivity advantages will continue to expand in population and area. Less productive cities and towns will grow at a slower pace.

The present urban population in the Lower Mekong Countries are as shown in Table 11.

Table 11: Urban Population in the Lower Mekong Basin Countries

	Cambodia	Lao PDR	Thailand	Vietnam
% of total	16	20	20	24.8

Source: ADB website - key indicators

5.2 Lao Perspective

5.2.1 Population

Lao PDR presently has a total population of approximately 5.4 million with an annual population growth of 2.8% (ADB key indicators). The country has a predominantly young population with 54 percent being under 20 years and as much as 70 percent under 30 years. With an area of 236,800 km², Lao PDR has the lowest average population density among the lower Mekong basin countries with 24 people per km².

5.2.2 Urbanisation

In Lao PDR urban areas are defined in different ways as the National Statistics Centre (NCA) uses one set of criteria while the Department of Housing and Urban Planning is applies another definition. This leads to different results in identifying what constitutes and urban area as well as the size of the urban population.

The definition of an urban area used by the National Statistics Centre is based on the five following criteria:

- The village / town has a permanent market
- The village /town has a road access suitable for motor vehicles
- The village / town must have or be located in the vicinity the district or provincial administrations
- Most of the households in the village / towns are electrified
- The majority of the households have installed piped water or access to piped water nearby the house

Using these criteria, the population census of 1995 found that 17% of the population were living in urban areas. The Department of Housing and Urban Planning, using their own criteria, estimated it to be 19% for the same year.

A third definition has been introduced by the Small Towns Development Project (ADB, 2003) representing the most recent approach to identification and classification of urban areas in the country. The local notion of an urban area, 'Thetsaban' was used as a basis for defining urban areas, even if this would sometimes include peripheral villages that were not included in any present infrastructure improvement plans but that in the future were anticipated to be an area of growth. Using the Thetsaban criteria combined with the requirement that the population should be above 5000 (with two exceptions being within 1% below this limit) the country was found to have 57 urban centres with a total population of approximately 989,178.

According to the 1995 census Vientiane Municipality was the most urbanised area of the country with 63 percent of its population classified as urban dwellers followed by Vientiane Province with 17.5 percent. The least urbanised provinces Bokeo in the north-west and Attapeu in the south, both with an urban population of 5.2 percent.

The urban areas that are growing most rapidly are the major towns, including Vientiane, Savannakhet, Luang Prabang and Pakse. The urban population in the largest towns are shown in Table 12.

Table 12: Population in the Largest Towns in Lao PDR

Town / Urban Area	Urban Population 2003	No. of Households	Household size
Vientiane Municipality	300,804	55,503	5.4
Luang Prabang	40,797	7,443	5.5
Pakse	48,218	8,202	5.9
Savannakhet	63,634	10,466	6.1

Source: Lao Urban Databook/Small Towns Development Project

5.3 Local Perspective

5.3.1 Population

Of the 3 provinces surrounding the project area Savannakhet is the largest with a population of 789,600 in 2001, representing 14.6% of the total population (NSC,

2002) of the country. Khammouane is less than half the size with 320,200 people (5.9%) while Borikhamsay has a population of only 192,300 (3.6%).

The number and percentage of urban dwellers in Borikhamsay, Khammouane and Savannakhet were as shown in Table 13. The 1995 census gives the highest figures for urban population while the Lao Urban Data Book, developed under the ADB Small Towns Development Project give lower figures even though they refer to 2003, 8 years after the NSC. The reason for this is obviously the stricter definition of urban area applied in the Lao Urban Data Book.

Table 13: Urban Population in the 3 Project Area Provinces

Province	Census 1995		Lao Urban Data Book 2003
	No. of People	%	No. of People
Savannakhet	100,278	14.9	91,450
Khammouane	36,605	13.4	38,939
Boikkhamsay	10,218	6.2	38,746

5.3.2 Urbanisation

The important urban areas to consider in the cumulative impact analysis are Thakhek, Gnommalath and Mahaxai in Khammouane, and Lak Xao in Bolikhamxai. Gnommalath district does, in a strict sense, not have any urban area, only a number of villages along or nearby Route 8B from where it crosses Nam and northwards. These villages include Gnaommalat, the administrative centre, Gnommalat Tay, Ban Hua Khua, Somsanok, Ban Nong Saeng and Keovilay. According to the 1995 census this cluster of villages had a population of around 1700 –2000 people.

Of all the districts surrounding the NT2 project area Mahaxay has had the largest growth in population with an average 3.6% per year. Growth has been more moderate in neighboring Gnommalath with only 2.3 % over the last years. As for the population growth in the district centres it may be assumed that it has grown at a higher rate than districts because of in-migration.

Thakhek, the provincial capital and largest urban area in the Khammouan has experienced an average annual population growth of 3.5 % over the last 8 years. A considerable part of it can be attributed to in-migration as the natural population growth for in the area can be assumed to have been around or below 3%.

Nakai District has seen an annual growth of around 3% from 1995 to 2003 while Odoumsouk or Nakai Town has grown at rate of 6%, a phenomenon most probably linked to the establishment of Nakai as a separate district and the vigorous logging activities that took place on the Plateau in this period.

Lak Xao, the administrative centre town in Khamkheut District is the only town in the area north of the NT2 Project area. It is a fairly large district town in the Lao context and its growth over the last years has been estimated to 2.7% annually (Norconsult, 2003)

Table 14 Urban and Rural Population in NT2 Influence Area

Area/Town	Population		Annual Increase - %
	1995	2003	
Thakhek Town (urban area)	25,768 ¹	33,017 ²	3.5
Nakai District	15,635 ¹	18,812 ⁴	2.5
Odomsouk (Nakai Town)	1,530 ^{3a}	1,900 ^{3b}	4.8
Mahaxai District	22,982 ¹	29,587	3.6
Gnommalath District	21,607 ¹	25,612 ⁴	2.3
LakXao (urban area)		12,774 ²	2.7

Sources: ¹ NSC Census, ² Lao Urban Data Book, ^{3a} SDP (figure for 1998),

^{3b} SDP, estimate based on no. of HH, ⁴ Data obtained at district level 2004

Thakek will continue to be a focal point for urbanization in the province in the future. The economy of Thakhek has to a large extent been fuelled by the timber industry that currently is experiencing a recession. However, because of its size and with the economic momentum of larger growth in other sectors like trade, service and tourism, Thakek will most likely continue to experience a relatively rapid population growth and associated urban expansion. One of the factors that in the short-term perspective will contribute to maintain the rapid growth and counteract the economic slump caused by the decline of timber industry, is the effect of the NT2 Project. A reasonable assumption will therefore be that Thakek both in the short and long perspective at least maintains a growth of 3.5%.

The economic perspective of Lak Xao is linked to the forestry industry and the cross-border trade with Vietnam. The forestry related activities are declining in Khamkheut but trade and traffic associated with the upgrading of Route 8 will most likely increase. Since there are no other towns in the area it is expected that urbanization in the eastern area of Bolikhamxay will focus on Lak Xao. In addition come the effects created by trade and traffic in connection with the construction of the Nakai Dam. Lak Xao will therefore continue to experience a high growth rate, probably slightly higher than in the past. A reasonable estimate would therefore be that future growth in population will be around 3% on an annual basis.

The future growth of Oudomsouk will be dominated and governed by the NT2 Project activities in the short-term perspective. As long as there are considerable construction activities on the Plateau this will uphold the rapid growth seen in the past. One workers camp with possibly as many as 800 workers will be located near the town. It must be expected that the associated influx of camp followers, employment seekers and small-scale business people will be as least as high. In addition comes the establishment of all the administrative offices with their staff and families. A rough guess would therefore be that the population of Oudomsouk would be around 3000 people by 2010 if construction activities still are ongoing. If the workers have left the population would possibly number 2000 to 2500 people.

Mahaxai District Centre will have its own dynamic in addition to the effect of the NT2 because of the planned cement factory and its location on Route 12. The number of workers that will be employed at the factory will possibly reach 300. Assuming that the population in Mahaxai is presently around 2000 the influx of workers and followers as well as associated service activities will possibly more

than double the population by 2010. From there on it may be assumed that the growth will remain high, possibly around 3%.

Gnommalat and the villages along Route 8 up to the regulating dam will experience a considerable population influx and increased urbanization pressure during the implementation of the NT2 Project. Although the 4 planned workers camps with up to 2,200 workers will be located in a forested area at some distance from Gnommalat, one can expect a rise in the population in the villages along the road leading to an amalgamation into a more contiguous urban area. The majority of these will be job seekers, traders and small-scale business people trying to capitalize on the increased economic activity in the area. A conservative guess would be that the inhabitants in the area along the road could reach 2,500-3,000 at the end of the construction period, discounting construction workers. After the construction period an operators village for possibly as many as 150 employees service facilities will be established in the area. Assuming that each employee has a family with 5 household members this will lead to a population increase of 750 after 2010. Afterwards, towards 2025 urbanisation would continue with a growth similar to that of Mahaxai.

Table 15: Estimated Population Increase in NT2 affected Urban Areas

Urban area	Estimated Growth Rate		Basis Population	2010	2025
	Up to 2010	2010- 25			
Thakhek	3.5	3.5	33,017 ¹	48,200	80,750
Odomsouk	-	3.0	1,900 ²	3,500	5,400
Mahaxai	-	3.0	2000 ³	4,000	6,200
Gnommalath	-	3.0	2000 ³	4,000	6,200
LakXao ¹	3.0	3.0	12,774 ¹	17,600	27,500

¹ Lao Urban Data Book (2003), ² Estimate based on SDP/RAP HH figures 2003, ³ Estimated present population

6 FORESTRY

6.1 Regional Perspective

The remaining forest areas in the lower Mekong is mainly found in Lao PDR and Cambodia. There is however, also some forest left in the Vietnam and Northeast Thailand. The following figures for forest cover have been calculated on the basis of the Mekong River Commission's GIS database.

Table 16: Forest Cover in the Mekong Basin (MRC 1997)

Country	Total area (km ²)	Forest area (km ²)	Forest cover
Cambodia	181,547	97,748	53.8%
Lao PDR	229,786	88,012	38.3%
Thailand	188,280	29,597	15.7%
Vietnam	67,456	14,127	20.9%
<i>Total</i>	<i>667,069</i>	<i>229,484</i>	<i>34.4%</i>

The MRC figure for Lao PDR diverges from that given in Forestry Strategy for Lao PDR (MAF, 2003) cited below. The discrepancy may be due to different definitions and different ways of measuring remaining forest resources.

During the 1990s, rules and legislation was issued in all countries aimed at effectively regulating and controlling logging and the use of forest resources. Implementation of these regulations has been hampered by weak and resource deficient government institutions and administrations. Thailand totally banned logging of natural forests and Vietnam severely restricted its scale and operation. Cambodia and Lao PDR attempted to manage the sector through concession regulations, but with limited success in terms of gaining control over logging activities.

Cambodia is the country with the highest forest cover of the Mekong basin. However, logging has steadily reduced the forest cover over the last decades and it is steadily declining due to excessive logging operations. The forest cover could thus be considerably reduced, perhaps to somewhere below 50% within a period of 5 years, reaching below 40% in 20 years time.

Having been reduced to just 15-16%, significant further reductions should not be expected in Thailand. In Vietnam increased agricultural activities could reduce the forest cover down towards 15% in the 20-year perspective

6.2 Lao Perspective

Lao PDR has over the last decades seen a relatively rapid reduction of its forest cover from 64 % in the mid-sixties to 41.5% today measured as forest with more than 20% canopy density. Although the stated goal is to increase the forest cover substantially there is a danger that it will continue to diminish also in the years ahead. If the decline continues at the same rate as in the last 35-40 years the forest cover could be reduced to 37-38% within in 5 years and down below 30% in 20 years.

A general ban on logging other than for certain concessions - based on a system of forest classification as "Production Forest" or "Protection Forest", has been in place in Lao PDR since 1993. Institutional capacity and a decentralised system of concession granting have however, limited its effectiveness. The provincial authorities are responsible for implementing the system, and since they acquire revenue from forestry (an average of 13.9 percent across the country for 1997) they have an economic interest in maintaining the activity. The issuing of quotas is biased and involves vested interests among various public sector institutions and officials. The result is a forestry management system that is not able to ensure the sustainability of forest resources.

At the policy level, the Lao PDR is encouraging conservation through zoning, protecting forests in steep areas and reforestation. A National Forestry Action Programme involving reforestation of 1.5 million ha of denuded lands has been initiated. Most of the envisaged planting is of fast growing exotics for fuel wood and pulp and paper production.

With regard to the distribution of forest resources across the country the central region is the most endowed. According to figures from 1996 the production forest area there constituted around 52 percent of the country's forest resources (Table 17). Measured in potential production forest volume, the region is even more dominant, accounting for close to 66 percent of total volume on a national basis.

The southern region stands out as the least endowed with only around 9 percent of the total national area.

Table 17: Regional Forest Area and Biomass in Lao PDR, 1996

Region	Forest Area		Production Forest		Potential Volume	
	ha	%	ha	%	m ³	%
Northern	3,902,000	39.7	969,000	39.0	18,773,000	24.1
Central	5,004,000	53.2	1,301,000	52.4	51,202,000	65.7
Southern	2,732,000	61.3	217,000	8.6	7,919,000	10.2
Total	11,638,000	49.1	2,487,000	100.0	77,894,000	100.0

Source: Lao PDR Production Forestry Policy Project, Main Report (figures from MAF)

Considering that the above figures are about eight years old and that comprehensive logging operations have taken place since then, the picture may have changed considerably. The central region has seen extensive logging and may now be more equal with the northern region with regard to remaining production forest resources.

Plans for logging are formulated on a yearly basis by the provinces and submitted to the Ministry of Agriculture and Forestry, Department of Forestry, for consideration and approval. There is allegedly a tendency that the finally approved plans are based more on a negotiations rather than on purely technical criteria and sustainability considerations. In the long time perspective, government policies and regulatory interventions will determine development. In the 'Forestry Strategy to the Year 2020 which presently is under preparation, but not yet adopted, some of the specific objectives addresses the need for future sustainable management and protection of forests:

- Control and eradicate processes that have led to reduction in forest cover and quality whilst improving the livelihoods of the rural to stabilise and increase forest cover and quality
- Bringing wood production from production forest areas under sustainable management in cooperation with local communities, and promote commercial tree plantation by farmers, smallholders, small and medium entrepreneurs and foreign investors
- Ensure protection of water resources and critical infrastructure through forest conservation

6.3 Local Perspective

Of the provinces considered in the Lao PDR Production Forestry Policy Project, Savannakhet has the largest tracts of forestland, followed by Bolikhamxay and Kammouan. Kammouan and Bolikhamxay are fairly evenly endowed, differing by only 3,510 ha in forestland area (Table 18).

Table 18: Forest Land Area in 3 Provinces

Province	Land Area	Forest Land	
	ha	ha	%
Bolikhamsay	1,486,300	966,095	65
Khammouan	1,631,500	962,585	59
Savannakhet	2,177,400	1,197,570	55

Source: Lao PDR Production Forestry Policy Project, Main Report (figures from MAF, 1995)

It must be assumed that forested land area has decreased considerably as comprehensive logging operations have been going on over the past years. It must be assumed that forestland area has decreased considerably as comprehensive logging operations have been going on over the past years. The following figures (Table 19) give an indication of the scale of timber harvesting that has taken place.

Table 19: Logging by Provinces 1998-1999

Province	Logging Volume
	m ³
Bolikhamsay	38,118
Khammouan	285,481
Savannakhet	99,496

Source: Lao PDR Production Forestry Policy Project, Main Report (figures from MAF)

Khammouan stands out as the province where the most comprehensive and intensive logging has taken place while Bolikhamsay has seen more limited operations in comparison.

It is assumed that the significant cumulative effects of developments in the forestry sector and the NT2 Project will primarily occur in the NT2 Project area itself and in adjacent forested areas such as the NBCAs.

The timber harvesting and logging industry has been one of the major sources of employment in Khammouane Province with around 5000 people engaged in it during its peak in the last half of the 1990s. In 1996 there were 9 privately owned sawmills, 5 joint venture sawmills and 1 kiln-drying facility in the Khammouane and Bolikhamsay Provinces relying on logging in the province. These facilities had a combined intake of around 325,000 m³ per year. In addition there is a plywood mill (near Mahaxay) and a chipboard factory in Khammouane with a combined intake of 100,000 m³ per year.

There are 2 designated production forest areas in Khammouane Province, each of around 60,000 ha. These are the Dong Khaphat-Nakating area located in the southeast between the Khammouane-Savannakhet border and the Xe Bangfai, and the Dong Phou Soi-Khamchouan located in the southwest between Route 13, the Savannakhet border and the Mahaxay-Xaibouathong road

It has been estimated that from 2005 the annual supply from these lowland production areas will be about 100,000 per year (IUCN, 2000b). The timber and

wood supply in Khamouan will thus be seriously deficit in relation to the current capacity of the wood processing industry. In fact, diminished wood supply has already led to a contraction in the industry and number of people employed in it.

In Boulikhamsay 8 sawmills and timber processing mills were operating in the province around year 2000 with a combined processing capacity of around 100,000 m³ per year. In addition, a large integrated wood-processing plant has been constructed at Lak Xao. The production capacity of this plant is assumed to be around 250,000 – 300,000 m³ per year

Today there is only one production forest area in Boulykhamssay Province with a potential yield that is far less than the current installed production capacity of the processing industry.

An initiative to improve sustainability in the forestry sector is the SUFORD project currently being implemented in Khammouane, Savannakhet, Salavan and Champassak. provinces. The project will work in 3 districts in Khammouane. Two of these, Mahaxai and Xe Bangfai, are located in also the NT2 impact zone. The 2 production forest areas form part of the project area. Project components include capacity building and sustainable forest management with demonstrations of management practices in the field including active participation of villagers. The field implementation will cover 528,000 ha of natural forest whereof 110,000 are in Khammouane Province. The implementation period started in 2003 and will continue up till 2007.

Another potentially important factor that will influence the forestry sector in the future is the development of tree plantations with fast growing species suitable for industrial use. The BGA Company is presently developing a total area of 154,000 ha in Boulikhamsay Province. One third will be planted to mainly *Eucalyptus camadulensis*. The plantation area is divided in several sub-plots situated between the Mekong and the mountain range from Pakkading in the north to the mouth of the Hinboun River in the south.

Finally, according recent initiatives from biggest rubber company, Thai Rubber Latex Corporation, Boulikhamsay is one of the 2 provinces that are considered for establishment of sizable rubber plantations. The company has already made some surveys of potential sites. If the investment goes ahead the company will establish around 14,000 ha (100,000 rai) of plantations in the country.

7 INDUSTRY

7.1 Regional Perspective

The most industrialised countries in the region are Vietnam and Thailand. However, in these countries most of the industrial activities take place outside the Mekong Basin. Cambodia and Lao PDR have only a modest industrial sector. In Thailand's part of the Basin, the main industry is food processing. Nakhorn Ratchasima is the main industrial centre of the Northeast.

In Lao PDR and Cambodia, industrial development is at an early stage, but the sector is rapidly expanding as especially the textile industry is growing fast. In both countries industrial development is concentrated in the capitals.

Industrial development will increase the need for water resources. The quality and quantity of industrial water demand varies significantly by country, industry and particular uses, ranging from high water quality for the beverage industry to brackish water or treated municipal effluent for cooling purposes.

7.2 Lao Perspective

Lao PDR presently has a small industrial base mainly concentrated to the Vientiane area and the major towns in the south of the country. Today Vientiane Municipality and Vientiane Province account for 63% of manufacturing output while Kammouan accounts for 15%, Savannakhet for 9% and Champasak for 6%. Only 2.5 percent of the total manufacturing production takes place in the northern region. Table 20 gives the number of different types of industrial enterprise by province.

Table 20: Number of industries and handicraft entities (Selected provinces 1998-1999)

Province	1998		1999	
	Middle	Large	Middle	Large
Vientiane Municipality	134	60	157	62
Vientiane Province	46	1	65	2
Savannakhet	41	10	57	10
Champasak	53	6	47	12
Bolikhamxay	22	3	34	5
Kammouan	8	18	25	19
Xayabury	33	-	37	-
Saravan	19	-	16	1
Sekong	15	-	96	-

Source: Statistical Yearbook 2001, NSC, Large = number of employees >100 persons; middle = number of employees between 10 and 99 persons

The industry sector's contribution to the economy in terms of percentage of GDP was 23.4 in 2001. Of this contribution, manufacturing dominated with the textile industry, accounting for 17.7 percent. The average annual industrial growth rate for the last decade was around 10 percent while the manufacturing part grew slightly faster with an average of 12 percent.

Lao PDR's strategy for industrialisation prioritises a number of sub-sectors including energy, agriculture and forest based industries, manufacturing, tourism, mining and production of construction materials. The Government will also focus on promoting the following industries:

- Labour-intensive industries that create income for people
- Natural-resource based industries
- Agro industries, and
- Import-substituting industries and production.

While larger-scale industries like textile production have higher employment potential, considerable emphasis will be placed on promoting and creating small and medium-scale enterprises. These enterprises will include village-based handicraft production and food processing, based on agricultural produce to raise

producers' incomes. Production for export will be encouraged along with production of selected consumer goods in order to reduce imports.

One important strategy is to create industrial zones in Vientiane Municipality, Savannakhet, Champasak and Oudomxay provinces. Savannakhet will be established as a special economic zone. This initiative also links up with the East-West Corridor Project and the building of a bridge over the Mekong.

7.3 Local Perspective

In terms of industrial production, Savannakhet is second only to Vientiane on the national scale. The factories and enterprises are concentrated in Savannakhet town and adjacent areas and comprise the production of electrical appliances, tobacco processing, canning of fruit based products and textiles. The establishment of a special economic zone is likely to attract more enterprises to the province.

Possible future developments include an oil refinery and terminal that will have the capacity to cover 50 percent of the country's consumption. It is not known at this stage how likely it is that the refinery will be constructed. If it becomes a reality it will probably not be built before 2010.

Wood processing (sawmills, etc) is the dominant industrial activity in Khammouane with a total of seven registered enterprises in 2001. The existing sawmills represent a considerable overcapacity. The present output of the plywood factory at Mahaxai is probably much lower than its actual capacity. New establishments are not expected within wood processing. In this sector consolidation is required, and focus is likely to be on value added processing from those enterprises that will be allowed to continue to operate. It is likely that sawmills not able to meet new requirements will be shut down.

A new cement factory is planned to be constructed in Mahaxai District. The construction work is planned to commence in November 2004 and a two year construction period is expected. 300 workers are expected to be employed on a permanent basis by the factory.

In Bolikhamxai the construction material industry dominates. In 2001 there were seven enterprises providing gravel and sand for different types of construction and building activities. Wood processing and production of mirrors also takes place. A notable enterprise is the extraction of chemical compounds from wood (Mai Ketsana) for use in the production of incense sticks and cosmetics.

The assumed industrial development in these provinces is included in the calculation of power demand for "Power System Development Plan for Lao PDR" (Meritec/Lahmeyer International, 2004). The point loads are shown in Table 21.

Table 21: Estimated power demand Central 2,1 grid (Meritec/Lahmeyer International, 2004)

Point Loads Items	Power Requirement	Commencement
Cement factory	20 MW	2005
Quarry	5 MW	2008
Gypsum & lead mine	5 MW	2006
Copper/gold mine	40 MW	2005
NT2 construction	4-8 MW	2006-2010
Irrigation schemes	10 MW	2003-2020

8 MINING

8.1 Regional Perspective

All the countries in the region have identified rich mineral resources, and more may be found, as many areas have not yet been surveyed. At present the economic exploitation of the resources is not very high.

In Cambodia, mineral investigations began in the 1950s when significant deposits of sapphires, rubies, alluvial gold, alluvial cassiterite, silica, bauxite, manganese and coal were found. The only significant exploitation carried out has been gemstone mining in the Battambang province. At these mines the gems are exploited by artisanal methods and more or less outside governmental control.

In the Dak Lak province of the Vietnam Central Highlands large reserves of kaolin and bauxite have been found. The bauxite reserve is estimated to be 5 billion tons. The prospect for exploitation seems remote due to the weak infrastructure, lack of water and lack of electricity for smelting.

Northeast Thailand is rich in salt and potash. Several large mining companies are now considering exploitation of a major potash deposit.

8.2 Lao Perspective

Lao PDR has significant mineral resources that are not yet exploited. The mining sector might develop to become an important element of the national economy in the future. Commercial mining of tin, gypsum, coal, salt, gemstones and construction materials has so far been carried out on a small scale.

The mining sector contributed 0.48% of the country's GDP in 2002, and is dominated by the production of gypsum and tin. Other mineral commodities produced in Laos include barite, coal, construction materials, gemstones, gold, limestone, and zinc. Undiscovered mineral resources of iron ore, potash, and rock salt are believed to be substantial. None of Laos' mineral resources, however, are considered of world significance.

At the Kaiso deposit in the Vang Vieng area, zinc ore is being mined and exported to Thailand for smelting and refining. The measured resources at the

Kaiso deposit were estimated to contain 23,000 tons of zinc. Gemstones are mined in Bokeo Province close to the provincial capital of Huayxai.

Cement is produced at two factories located at Vang Vieng in Vientiane Province. Cement production was estimated to be 92,000 tons in 2001. Coal is produced by the State Coal Mining Enterprise (SCME) from the Chakeui Mine (anthracite) in Salavan Province, the Hongsa Mine (lignite) in Sayaboury Province, and the Vieng Poukha Mine (lignite) in Luangnamtha Province. Most coal output is for domestic consumption mainly by the cement plants while the output from the Vieng Poukha is exported to Thailand. SCME produces barite for export to Thailand from the Na Ang (Nalang) Mine in the Muong Feuang Valley in Vientiane Province.

The Australian Company, Pan Australian Resources NL, are planning to start mining gold at Phu Bia, located north of Vientiane, in March 2005

8.3 Local Perspective

Located on the Nam Pathen tributary to the Nam Hinboun there are mines producing heavy metals like tin, lead and zinc. Some of the mines have been in operation for decades, but it is difficult to get any precise information about the level of activity and the processes used. Recent observations, however, indicate that the settling pond systems and pollution control is of a very low standard. There is presently high activity at the mines, which contributes significantly to pollution problems in Nam Pathen and the lower part of Nam Hinboun. High levels of turbidity can be observed. Regular monitoring is not carried out but one sample from July 1995 shows high levels of several heavy metals including lead, zinc, tin and cadmium. The content of iron was extreme (18,700 µg/l compared to the WHO and Lao PDR standard of 300 µg/l). In the same period the iron concentration in the lower Nam Hinboun also exceeded the water quality standards (NORPLAN 1997). There is a concern that the mining activity leads to high concentrations of heavy metals in fish and other aquatic organisms.

Alluvial gold is found in Nam Kata a tributary to Nam Phao downstream Lax Xao. Prospects exist for commercial exploitation. At present gold is extracted by artisanal means, which includes the use of mercury. No monitoring of the potential water pollution seems to have taken place.

Gypsum is produced by the State Gypsum Mining Enterprise from the Dong Hene mine in Savannakhet Province. Proven ore reserves at the mine are estimated to be 18 million tons. Gypsum production has increased steadily in the past 4 years because of increased demand by the domestic cement industry and increased exports to Vietnam. Several limestone quarries are presently under operation in Khammouane and Bolikhamxai.

Further developments are foreseen in Savannakhet Province in a long-term perspective. The province has deposits of lead and zinc in the eastern part near the Vietnamese border that might be economically attractive to mine.

The only large-scale mining project within the three provinces that surround the NT2 project area, are the gold and copper mines in Xepon District in Savannakhet. The concession holder and operator of the mines is Oxiana Limited acting through its subsidiary in Lao PDR, Lane Xang Minerals Limited. The gold mine produced 73,247 ounces (2,076 kg) of gold and 35,622 ounces (1,010 kg) of silver the first half of 2004. Gold production is targeted to increase

to 200,000 ounces in 2005 and to nearly 400,000 in 2007. Total reserves of gold are estimated at 2.09 million ounces.

Production of copper from their Khanong mine located in Xepon District is expected to start in the first quarter of 2005. A production plant with a capacity of 60,000 tons per year is currently being build at the site. The Khanong mine is estimated to contain 1.21 tons of copper. The Power System Development Plan from 2004 has included the production plant's energy need in their in their demand forecast, amounting to 40 MW from 2005.

The social and environmental impacts of the copper mine and the production plant are expected to be considerable. The Environmental Impact Assessment for this project is presently under review by STEA.

9 CONSERVATION

9.1 Regional Perspective

9.1.1 *Biodiversity values*

The Lower Mekong region is uniquely rich in biodiversity due to its position as a "bridge" between the Asian continent and the Indo-Malayan bio-geographical regions and the rather isolated and sparsely populated areas in Cambodia, Lao PDR and Vietnam. According to the International Union for the Conservation of Nature (IUCN) Cambodia and Lao PDR have the highest species density in Southeast Asia, whereas Thailand, Myanmar, and Vietnam are highest in species endemism.

For example, 10 percent of the world's mammal, bird, and fish species are found in Vietnam and 40% percent of the 12,000 local plant species are endemic. Vietnam's forests contain the highest bird and primate diversity in mainland Southeast Asia. The recent discovery of new species of large mammals in the border area between Lao PDR and Vietnam (including Nakai Nam Theun NBCA) reinforce the global significance of the country's rich biodiversity. The most prominent species discovered in the 1990ties are the ungulates Saola and Giant Muntjac. Other new mammals have also been observed but their validity as new species are still to be confirmed.

The rate of species and habitat loss is however, high in the region. In particular in Thailand and Vietnam there have been large changes in land use causing significant loss in natural vegetation and consequently of biodiversity. In addition there are severe problems with logging and illegal hunting and wildlife trade in the region.

The fish biodiversity is also unique. It is estimated that about 1300 different fish species are found in the Mekong Basin. Several of these are endemic and globally threatened.

9.1.2 *Nature protection*

Lao PDR

Lao PDR biodiversity is protected through the establishment of 20 protected areas, called National Biodiversity Conservation Areas (NBCAs), comprising 12-14 percent of the total land area.

Thailand

The government of Thailand has taken measures to conserve the biodiversity by establishing protected areas. Two acts have formed the basis of Thailand's conservation strategy: the Wild Animals Reservation and Protection Act (1960) and the National Park Act (1961). The first national park was established in 1962 and presently there are 77 national parks covering an area about 4 million hectares.

Cambodia

In 1993, a new National Protected Area System was established in Cambodia, giving the Ministry of Environment authority to supervise, develop, and manage areas totaling more than 3 million ha in cooperation with the Ministry of Agriculture. The new system designates seven national parks, nine wildlife sanctuaries, three protected landscapes, and three multiple-use management areas.

The conservation efforts have helped to reduce habitat destruction from logging and other unsustainable use. The management capacity has, however, been slow to develop and has not been able to halt illegal logging.

Vietnam

In 1997, the Government undertook to increase the number of terrestrial protected areas from 87 to 101 and to increase the size of most units. This initiative would increase the total area from 1.1 to 2.2 million ha, amounting to 6 percent of the country. Vietnam has made progress in protected area management. Management boards have been established for 10 national parks and, over the past 10 years, management plans for parks have increased from 20 to 44.

9.2 Lao Perspective

Lao PDR is endowed with an unusually rich biological diversity. The high and isolated mountains have created wide variations in climate, soils, and ecological niches, leading to locally adapted and diverse fauna and flora.

Biodiversity is protected through the establishment of 20 protected areas, called National Biodiversity Conservation Areas (NBCAs) (Table 22). The protected areas comprise 12-14 percent of the total land area. The establishment has been based on criteria developed by the IUCN. Twelve of the NBCAs have received international funding support to establish integrated management plans for the protected areas.

In addition to the centrally designated protected areas, large areas have been designated as protection or conservation forests at the provincial and district levels, some to be upgraded to official protected area status in the future. Together, the protected areas and the provincial and district conservation and protection forests cover 8 million ha.

Table 22: National Biodiversity Conservation Areas in Lao PDR (DoF 2000)

Name of NBCA		Year	Area (ha)	Provinces covered
Dong Amphan	DAP	1993	200,000	Attapeu, Xekong
Dong Hua Sao	DHS	1993	110,000	Champassak
Dong Phou	DPV	1993	197,000	Savannakhet
Hin Namno	HNN	1993	82,000	Kammouan
Nakai Nam Theun	NNT	1993	353,200	Kammouan, Bolikhamsay
Nam Et	NET	1993	170,000	Houaphan
Nam Ha	NHA	1993	222,400	Luang Namtha
Nam Kading	NKD	1993	169,000	Bolikhamsay
Nam Phui	NOI	1993	191,200	Sayaburi
Nam Xam	NXM	1993	70,000	Houaphan
Phou Daen Din	PDD	1993	222,000	Phongsaly
Phou Hin Phoun	PHP	1993	150,000	Kammouan
Phou Khao Khouay	PKK	1993	200,000	Vientiane, Bolikhamsay, Xaisombun
Phou Loei	PLI	1993	150,000	Houaphan, Luang Phabang
Phou Phanang	PPN	1993	70,000	Vientiane
Phou Xang He	PXH	1993	109,900	Savannakhet
Phou Xiang Thong	PXT	1993	120,000	Champassak, Salavan
Xe Bang Nouan	XBN	1993	150,000	Salavan, Savannakhet
Xe Pian	XPN	1993	240,000	Attapeu, Champassak
Xe Sap	XSP	1995	133,500	Salavan, Xekong
TOTAL			3,313,596	

The Lao PDR has until recently been sheltered from many of the forces acting to reduce biodiversity. However, as the economy of the Lao PDR expands this situation is changing rapidly and threatens the country's biodiversity resources.

Most plans and initiatives in terms of biodiversity conservation come from national authorities. GoL has officially devolved responsibility for national policy implementation to provincial governments and relevant agencies. Even though government agencies like STEA have provincial offices, they are mainly carrying out tasks that have been outlined in national plans and strategies. However, a major problem is the lack of awareness and support for biodiversity conservation among the local population. Without such support it is difficult to enforce the protection and management principles developed by central and provincial authorities.

9.3 Local Perspective

In Kammouan, Bolikhamxay Savannakhet there are altogether 8 NBCAs. 5 of these are located to the catchments of Nam Kading and Xe Bang Fai. These include:

- Nakai Nam Theun NBCA, 353,200 ha
- Phou Hin Phoun NBCA, 150,000 ha
- Nam Kading NBCA, 169,000 ha
- Hin Namno NBCA, 82,000 ha, and
- Phou Xang He NBCA, 109,900 ha

Nakai Nam Theun NBCA (NNT)

The NNT NBCA is situated on the upper reaches of Nam Theun, between the Nakai Plateau and the border with Vietnam. This is the largest NBCA in Lao PDR and contains the most diverse combination of natural forest. Its biodiversity is unique and contains at least 3 of the 5 large mammals discovered worldwide in recent years. Two corridors have been established, one to connect the NNT with the Phou Hin Phoun NBCA to the west and another, smaller corridor to connect NNT with Hin Namno NBCA to the south.

Plans exist to extend the NBCA to the north as a largely undisturbed forest area consisting of about 450 km², has been gazetted as the *Nam Chat/Nam Pan Provincial Conservation Forest*. The NT2 Project will provide the Nakai-Nam Theun NBCA with annual funds of US\$ 1 million. This will be an important contribution in order to protect this globally important NBCA against further encroachment from loggers and poachers.

Nam Kading NBCA (NKD)

The protected area covers the mountainous areas in the lower part of the Nam Kading catchment. For biodiversity values it is ranked as being of medium/high importance, primarily because of the mountainous evergreen forest. Forest corridors linking NKD with the Kammouan Limestone – Nakai Nam Theun complex to the south have been proposed. A buffer zone with authorized sustainable local use but with a ban on commercial logging is being planned.

Hin Namno NBCA

This is a small NBCA in the upper Xe Bang Fai catchment on the border to Vietnam, which is linked to the NNT by a narrow gazetted corridor. The biodiversity value is high due to the remote location and the steep terrain. The area is home to numerous distinct ethnic groups. An extension to the south to cover more of the headwaters of Xe Bang Fai has been proposed.

Phou Hin Phoun NBCA

This NBCA is also known as the Kammouan Limestone Area. It consists of limestone karst ranges with steep slopes, cliffs and caves. The forests are rather dry and contain habitats for globally and nationally important primates, birds and reptiles. The established corridor with NNT and the planned corridor with NKD will increase the importance and value of Phou Hin Phoun NBCA.

Phou Xang He NBCA

This area is located south of the Xe Nou, a major tributary to the Xe Bang Fai. It is a hilly area containing many species that are globally threatened. An extension of 117 km² to the west and south to incorporate a still largely undisturbed forest area has been proposed.

In spite of the fact that NBCAs have been established, the unique value of the biodiversity in the Bolikhamxay and Khammouane Provinces are under serious threat. In general for the NBCAs in Lao PDR logging and slash and burn cultivation are seen as the most serious threat to biodiversity. In these two provinces, however, and in particular in the western parts, wildlife trade is seen as an even more acute problem (IUCN, 2000). The centre of this trade is supposed to be Lax Xao and about 60-70 % of the goods is assumed to go to Vietnam and eventually to China.

The lower part of the Xe Bangfai plain is highly developed with little natural habitat and wildlife left. A large tract of previously forested land west of Hin Nam No NBCA has been cleared by logging and consequently also lost most of its biodiversity value.

The Wildlife Conservation Society (WCS) is planning a 5-year project in Bolikhamxay Province, co-financed by GEF. Provided that the project plans are approved by GEF and the GoL, this will bring biodiversity conservation in this region an important step forward.

10 POVERTY AND ECONOMIC DEVELOPMENT

10.1 Regional Perspective

During 1985-95, Thailand was one of the fastest growing economies in the world with an average annual rate of growth of over 8 percent. However, the Asian financial crisis that started in 1997 led to an economic slump from which the country now is slowly recovering. While the GDP contracted by minus 10.5% in 1998 the economic growth amounted to an estimated 6.7% in 2003.

Largely escaping the effects of the Asian crises economic growth in Vietnam has been increasing rapidly over the last decade as the country has moved towards a more market-oriented economy. For the period 2000-2003 GDP has grown with around 7% annually. The Vietnamese economy is still expected to grow at a relatively high rate.

While Cambodia experienced a relatively low economic growth during the first half of the 1990s the last years have seen a strong growth of the GDP peaking in 1999 with 10.8% leveling off to an estimated 5.1% in 2003. Continued strong economic growth is expected in the years to come.

Economic development has primarily been concentrated to urban areas and at least part of the urban population has experienced substantial increases in standards of living. The quality of life for poorer people, mainly the rural part of the population, has, however, not changed to a lesser degree. The rural population constitutes more than 80 percent of the total population in the Mekong Basin.

Poverty is a universal problem in all rural areas of the Mekong River Basin. Indicators, such as literacy, health, and access to safe drinking water, are quite low in Cambodia and Lao PDR. For Thailand and Vietnam the part of the countries belonging to the Mekong Basin generally indicate lower figures than the parts outside the basin.

10.2 Lao Perspective

Much of the economic activity in Lao PDR is confined to the Mekong Corridor leaving the remote and mountainous areas lagging behind in the relatively rapid development the country now is experiencing. The agriculture sector employs around 80% of the population and accounts for approximately half of GDP. The industry and service sector each account for around 25%. In the period 2000-2003 GDP has grown by around 5.8% annually. Industry is the fastest expanding sector with an estimated growth of 11.3% in 2003.

Lao PDR, along with Cambodia, has the highest poverty occurrence in the region, with more than three quarters of the population living on less than US\$2-a-day. However, household surveys show a decline in poverty from 45 percent in 1992/3 to 38.6 percent in 1997/8 measured against the national poverty line. The latest preliminary government estimates indicate that poverty has dropped to approximately 30 percent in 2003/3. Poverty in rural areas is almost twice as high as in urban areas. In Vientiane Municipality, only one in seven people fall below the poverty line, compared to about one in two for the rest of the country.

Poverty varies across regions and provinces. The North is the poorest region, with a poverty incidence in rural areas of 53% in 1997/98. In the Southern and Central Regions the rural poverty incidence at the same time was 39 and 36 percent, respectively (GoL, 2001)

Poverty alleviation is now the overarching goal for the Lao Government. In the Interim Poverty Reduction Strategy Paper (I-PRSP) a broad strategy for poverty reduction is outlined. Four sectors are identified as particularly important: agriculture and forestry, education, health and road infrastructure. Improved governance and sound macroeconomic policies are identified important underlying and enabling conditions. The I-PRSP was elaborated in a national Poverty Eradication Plan presented in 2003. The Government is committed to halve poverty by 2015, which is one of the Millennium Goals adopted by Lao PDR.

10.3 Local Perspective

According to the Lao Expenditure and Consumption Survey (LECS) carried out in 1992/93 and 1997/98 the incidence of poverty has declined slightly in Khammouan and Savannakhet while it in Bolikhamxai has increased substantially. However, the figures for Boulikhamsay is so much lower than the national average and neighboring provinces that some doubt can be raised about their accuracy and validity.

Table 23: Poverty Incidence by Provinces Surrounding NT2

Province	1992/93	1997/98
Bolikhambxai	10.6	25.8
Khammouan	43.7	41.6
Savannakhet	45.7	37.1
National average	45.0	38.6

Source: Interim Poverty Reduction Strategy Paper, 2001

In connection with the national poverty reduction strategy work all villages and districts in the country has been classified in relation to the calculated national poverty line. This resulted in 72 districts being categorized as poor and 70 as non-poor. Out of these 72 districts 47 have been earmarked for special priority interventions to reduce poverty. Table 24 lists the poverty classification of the districts in the 3 provinces in NT2's influence zone.

Table 24: Poor Districts in Provinces Surrounding NT2

Province	Poor Priority Districts	Poor Non-priority Districts	Non-poor Districts
Boulykhamxay	Bolikhan Khamkeuth Viengthong		Pakkading Pakxanh Thaphabat
Khammouan	Boulapha Nakai	Gnommalat Mahaxay Xaybouathong	Thakek Nongbok Xe Bangfai Hinboun
Savannakhet	Nong Xepone Phin Vilabouly	Thaphangthong Xonnabouly Phalanxai	Xaibouly Outhoumphone Khantabouly

In terms of poverty reduction efforts in the NT2 influence area the World Bank is currently preparing a project aiming to improve livelihoods and enhance opportunities for the downstream rural population in the Xe Bangfai basin. The core districts will be the Gnommalat, Mahaxay, and Xe Bangfai while Boulapha, Nongbok and Xaibouly may receive more specifically targeted assistance. The project is intended to improve the local populations opportunities to benefit from the economic development that is expected to result from the NT2 Project. Interventions will include activities to improve market linkages through building an improved rural access road network and strengthening marketing organisations, improvement of natural resource management, increased agricultural productivity through diversification and extension, and, enhancing women's opportunities to participate in the economic development. The Government has also requested the project formulation team to consider interventions also in the health and education sector. Due to the funds available it has been recommended that the project does not engage in irrigation development.

11 EDUCATION

11.1.1 *Regional Perspective*

Laos and Cambodia are the countries in the Lower Mekong Basin with the poorest education performance and indicators while Thailand and Vietnam in comparison have well developed education systems.

Table 25: Education Indicators 2001/2002 – LMB Countries

Country	Adult Literacy %	Gross Enrolment Ratio – Both Sexes		
		Primary	Secondary	Tertiary
Thailand	92.6	98	83 ¹	29
Vietnam	90.3	103	70	11
Cambodia	69.4	123	21	3
Lao PDR	66.4	115	41	4

Source: UNESCO Institute for Statistics website, ¹ 2000/2001

The high Primary gross enrolment rate in Lao PDR and Cambodia indicate a high number of overage pupils in the primary school age bracket.

11.1.2 *National Perspective*

The Lao formal education system includes five levels: five years of primary education, three years of lower secondary education, three years of upper secondary education, one to two years of post secondary education and three to seven years of tertiary education.

In general the education sector in Lao PDR suffers a lack of funds for salaries and schooling facilities and a lack of qualified personnel. This situation is most pronounced in the more remote parts of the country in the north and the south. This situation is exacerbated by the fact that the population is young and the majority of school age children live in rural areas. Years of schooling average 2.9 - 3.6 for boys, and 2.1 for girls.

In 2001 the net primary school enrolment rate had reached 80 percent, up from 62 percent in 1990. The Government aims at achieving full enrolment before 2015.

11.1.3 *Local Perspective*

In terms of spending on education Khammouane Province allocated around 1.8 million Kip per student in 2000 (JICA/CPC 2001). Among all 18 provinces in Lao PDR Khammouane was the third lowest. Vientiane and Sekong spent most per student with around 9 million Kip. Some indicators for the education sector in Khammouane Province is shown below.

Table 26: Education Indicators for Khammouane Province 1998

Indicator	Primary	L. Secondary	U. Secondary
Number of Schools	520	46	9
Enrolment Ratio	76.4	24.8	10.6
Number of Students	47,494	6,741	2,241
Dropout Ratio	20.0	-	-
Repetition Ratio	24.0	-	-
Teacher-Student Ratio	1:31	1:13	1:11
Number of Teachers	1,509	-	-
% of Unqualified Teachers	38.0	-	-

Source: JICA/CPC, 2001

REFERENCES/BIBLIOGRAPHY

ADB, 2000, *Environments in Transition - Cambodia, Lao PDR, Thailand, Vietnam*

Division of Forest Resources Conservation, DoF, 2000, *Fact Sheets for National Biodiversity Conservation Areas in the Lao PDR*

Government of Lao PDR - Committee for Planning and Cooperation, 2003, *Foreign Aid Report 2001 – 2003*

Government of Lao PDR, 2003, *the National Poverty Eradication Programme (NPEP), Background Document*

Government of Lao PDR - Nam Theun 2 Watershed Management and Protection Authority, 2002, *Social and Environment Management Framework and 1st Operational Plan*

Government of Lao PDR - Nam Theun 2 Watershed Management and Protection Authority, 2002, *Social and Environment Management Framework and 1st Operational Plan, Folio of Annexures*

Government of Lao PDR (GoL), 2001, *Interim Poverty Reduction Strategy Paper*.

Meritec / Lahmeyer International, 2004, *Power System Development Plan for Lao PDR*.

Ministry of Agriculture and Forestry, 2003, *Forestry Strategy to the Year 2002, Second Draft*

Ministry of Agriculture and Forestry, Department of Irrigation, 2000, *Feasibility of Medium and Large Scale Irrigation Schemes in 7 Large Plains in Lao PDR*

Ministry of Agriculture and Forestry, Forest Inventory and Planning Center, 2001, *Forest Inventory and Preliminary Harvesting and Management Considerations, Nam Theun Resettlement Tract, Nakai District and Gnommalat District*

Ministry of Education, 2000, *The Education Strategic Vision, a Discussion Paper prepared for the Donor Meeting*

Ministry of Health, 2000, *Health Strategy up to the year 2020, a Discussion Paper Prepared for the Donor Round Table Meeting*

MOH Technical Working Group and JICA Study Team, 2001, *Lao Health Master Planning Study, Progress Report 1*

MRCS 2001, *MRC Hydropower Development Strategy*

MRCS 2002, *Basin Development Plan - Inception Report*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Agriculture and Irrigation*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Executive Summary and Sectors*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Fisheries*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Flood Management and Mitigation*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Hydropower.*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Navigation*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Tourism Development*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Watershed Management*

MRCS, 2002, *Basin Development Plan. Regional sector overview, Water Supply (Domestic Water & Sanitation; Industrial Water Use)*

MRCS, 2003, *MRC Navigation Strategy*

NTEC 2003, *Environmental Assessment and Management Plan, Main Text, Draft*

NTEC 2003, *Social Development Plan, Volume 1: Ethnic Minority Development Plan*

NTEC 2003, *Social Development Plan, Volume 2: Resettlement Action Plan*

NTEC 2003, *Social Development Plan, Volume 3: Appendices*

NTEC, 2003, *Xe Bang Fai Strategy Paper, Draft – Revision C*

SEATEC and Sinclair Knight, Merz ECI INC. 1997, *Nam Theun 2 Hydroelectric Project - Environmental Assessment and Management Plan (EMAP)*

SIDA and Department of Environment/STEA 2002, *Strengthening environmental Management Project- Evaluation report*

State Planning Committee, National Statistical Centre, 1997, *Results from the Population Census 1995,*

State Planning Committee, National Statistical Centre, 2002, *Statistical Yearbook 2001*

Vietnam – Laos Cooperation Program on Water Resources Planning, 1999, *Project on Water Resources Development Planning for Kammouan, Final Report*

Vietnam – Laos Cooperation Program on Water Resources Planning, 1999, *Project on Water Resources Development Planning for Savannakhet, Final Report*

Vietnam – Laos Cooperation Program on Water Resources Planning, 2000, *Project on Water Resources Development Planning for Bolikhamxay, Final Report*

World Bank, 2003, *Lao PDR at a Glance, website*

World Bank, 2003, *Lao PDR Economic Monitor, Vientiane Office*

World Bank/SIDA/Ministry of Foreign Affairs, Government of Finland, 2001, *Lao PDR Production Forestry Policy, Status and Issues for Dialogue, Main Report, Volume 1 and 2*

Worley International Ltd. and Lahmeyer International, 2000, *Hydropower Development Strategy Study.*



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ANALYSIS AND NAM THEUN 2 CONTRIBUTIONS



Annex 2: HYDROLOGY REPORT

Hydraulic simulations and hydrological analysis

Prepared by: Jean-Pierre Bramslev

November 2004

TABLE OF CONTENTS

1	INTRODUCTION	1
2	HYDROLOGICAL REFERENCE SERIES	2
2.1	Hydrological trends in the Reference period 1950-2000.....	2
2.2	Projected Reference Series	5
3	WATER BALANCE MODELLING	6
3.1.1	Baseline	6
3.1.2	NT2 Impacts.....	7
3.1.3	Cumulative Impacts	8
4	HYDRAULIC MODELLING	11
4.1	General Set-up	11
4.2	Input Data.....	12
4.3	Calibration	12
4.4	Baseline Simulations	14
4.5	Scenario Simulations.....	16
4.5.1	NT2 Impact Simulations.....	16
4.5.2	Cumulative Impacts 2010 and 2025.....	19
4.5.3	Impacts in the Delta	22
5	REFERENCES	35

LIST OF TABLES

Table 1	Hydrological Reference Series.....	2
Table 2	Deforestation History and Forecast in Lao PDR in terms Forest Cover (Percentage of the total Surface of Lao PDR).....	4
Table 3	Overview of planned reservoirs in the Mekong Basin, as input to hydrological simulations. Grouped by river sections.....	9
Table 4	Summary of key simulation results for impacts on Tonle Sap Lake: Wet Season	21
Table 5	Summary of key simulation results for impacts on Tonle Sap Lake: Dry Season	21
Table 6	Monthly Mean Sea Water Levels at the Mekong Delta (unit: cm).....	27
Table 7	Monthly Maximum Tidal Amplitude at the Mekong Delta in 1985 (Unit: cm)	27

LIST OF FIGURES

Figure 1	Trends in Mekong Discharges 1925-2000.	3
Figure 2	Detail of MikeBasin water balance model for hydrological simulations: The baseline setup simulates only TH hydropower. The little figure shows the entire model area.....	6
Figure 3	Detail of MikeBasin water balance model for hydrological simulations. Setup for simulation of NT2 operation. Compare with Figure 2.	7
Figure 4	Result of reservoir simulations of NT2: Reservoir inflow, turbine discharge and spills. Weekly average discharges 1950-2000.....	8
Figure 5	Simulated turbine discharge at Theun-Hinboun HP, pre-NT2 baseline (bold red) and post-NT2 (blue with markers).....	8
Figure 6	Input to MikeBasin water balance calculation: Regulation in Yunnan (2010 and 2025), as a result of hydropower simulations.....	10
Figure 7	Result output from MikeBasin water balance simulations: Mekong Discharge at Kratie – baseline and regulated (cumulative 2010 and 2025).	10
Figure 8	Schematic view of the hydraulic model of the Tonle Sap and Mekong Delta.....	11
Figure 9	Location of gauging stations used for calibration (triangles).....	14
Figure 10	Simulated daily water level in Tonle Sap Lake 1960-2001 (Baseline).	15
Figure 11	Simulated water level in Tonle Sap Lake (blue with markers) and at Mekong/Tonle Sap confluence at Phnom Penh (bold red). Baseline situation.	15
Figure 12	Longitudinal profile from Mekong upstream, through Tonle Sap river to the Lake. Simulated water level during rising floods (August): Water is filling into Tonle Sap.	16
Figure 13	Longitudinal profile from Tonle Sap Lake trough Tonle Sap river, Bassac to the Delta. Simulated water level during flood recession (December): Water is draining out of the Lake.	16
Figure 14	Input to hydraulic simulations, discharge at Kratie. Baseline and post-NT2.....	17
Figure 15	Daily Simulated Tonle Sap water level: Post-NT2.....	17
Figure 16	NT2 impact on Tonle Sap lake levels: Simulated change of lake level (post-NT2 minus baseline). Negative figures means reduced level. Should be related to Figure 15.	17
Figure 17	Summary of simulations 1950-2000 of NT2 impacts on Tonle Sap lake levels. Mean, 10% and 90% percentiles of 50 years of simulations.	18
Figure 18	Annual Maximum Water Level, Tonle Sap. Baseline and post-NT2.	18
Figure 19	Input to hydraulic simulations: Discharge at Kratie as a result of cumulative impacts 2010 and 2025.	19
Figure 20	Simulated Tonle Sap water levels: Cumulative Impacts 2010 and 2025.	19
Figure 21	Change of Tonle Sap water level. Average of entire 50 years simulation period, 2010 and 2025 Cumulative Impacts.....	20
Figure 22	Annual Maximum Water Level in Tonle Sap (September or October). Baseline, 2010 and 2025 Cumulative Impacts.....	20
Figure 23	Observed Mekong discharges under tidal influence. Stations Tan Chau at Cambodian/Vietnamse border and my Thuan 90km further downstream. Source:WUP-JICA 2003.....	22

Figure 24	Simulated tidal oscillations of discharge in the Mekong Delta. Two lines outline the “envelope” of negative flows for the two scenarios: pre- and post-NT2.	24
Figure 25	Flow Duration Curve (Discharge interval <6000 m ³ /s, i.e. dry season). Illustrates scenario impacts on flow duration: Duration of negative discharges is reduced due to regulation. The bold frame indicates the area that is zoomed to on Figure 26.	24
Figure 26	Flow Duration Curve (Discharge interval <2000 m ³ /s). Illustrates scenario impacts on flow duration: Duration of negative discharges is reduced due to regulation.	25
Figure 27	Storage Curve for Tonle Sap Lake. Established by Tes et al (1998).	27
Figure 28	Selected Example Cross Section Profiles.	28
Figure 29	Inundated areas on 30 th August 2001 (light blue). Figures are used as floodplain storage in Mike11. All figures in square km. Dark blue areas are permanently inundated.	29
Figure 30	Tidal effects in the Delta. Simulated water levels and discharges. Note negative discharges (reverse flow) in the dry season, i.e. saltwater intrusion. Reporting points located 10 - 170 km from river mouth (mouth = 212,000).	30
Figure 31	Calibration Result, Tonle Sap river at Prek Kdam: Comparison of observed and simulated water levels (above) and discharges (below).	31
Figure 32	Calibration Result: Comparison of observed and simulated discharges at Neak Luong (above) and water levels at Kompong Cham (below).	32
Figure 33	Result of reservoir simulations: Nam Kading discharges at Pakkading (Mekong Confluence). Baseline and post-NT2.	33
Figure 34	Result of reservoir simulations: Xe Bang Fai discharges at Mahaxai. Baseline and post-NT2.	33
Figure 35	Simulated NT2 impact on Tonle Sap lake levels: Difference between daily lake levels pre- and post-NT2 ($\Delta H = H_{NT2}$ minus $H_{baseline}$). Negative figures means reduced level.	34

1 INTRODUCTION

This annex analyses the hydrological and hydraulic impacts from various development scenarios for the nearest 5-20 years in the Mekong Basin and from NT2 in particular. The analysis is divided into two separate modelling tasks: **a)** hydrological modelling of the impacts Nam Theun, Xe Bang Fai and in the mainstream Mekong and **b)** hydraulic (hydrodynamic) modelling of the hydraulic impacts in the Mekong/Tonle Sap/Delta area.

The regulating impacts of envisaged hydropower construction in Yunnan and in the basins of Nam Ngum and Se San/Se Kong/Sre Pok are analysed and reported separately in Annex C. The results of that analysis is used as input for the analysis in the present Annex B.

The analysis is based on 50 years reference series of discharges in the Mekong and most important tributaries. The purpose of this is that such a long hydrological record is expected to include most thinkable combinations of hydrological events, for example of large floods in the Mekong and small floods in the tributaries and vice-versa, etc. By including such a large amount of data in the analysis, it is likely that the result will also be representative for the variety of events to be expected in the future.

In order to ensure that the main trend in the 50 years reference series is representative for the envisaged scenario period, an analysis has been carried out in order to give a best estimate for the future average situation. This analysis is presented in the following section.

2 HYDROLOGICAL REFERENCE SERIES

The hydrological analyses are based on observed discharges, made available by the Ministry of Industry and Handicrafts (MIH), by the Mekong River Commission and by the NTPC.

The information comprises the gauging stations in the Mekong main river as listed below (see small map in Figure 2). In addition, discharge information was available for Xe Bang Fai and Nam Theun at Ban Signo/Thalang. The latter is however a computed series (by correlation with other hydrological information), presented in the NT2 EIA.

Table 1 Hydrological Reference Series

	Name	River	Period	Time Unit	Comment
1	Chiang Saen	Mekong	1950-2000	Monthly	
2	Vientiane	Mekong	1925-2000	Monthly	
3	Nakhon Phanom	Mekong	1925-2000	Monthly	
4	Mukdahan	Mekong	1925-2000	Monthly	
5	Pakse	Mekong	1925-2000	Monthly	
7	Kratie	Mekong	1925-2000	Monthly	Established by correlation with Pakse.
8	Kompong Cham	Mekong	1960-2000	Daily	For calibration of hydraulic model
9	Prek Kdam	Tonle Sap	1960-2000	Daily	For calibration of hydraulic model
10	Neak Luong	Mekong	1960-2000	Daily	For calibration of hydraulic model

The Mekong flow data were examined in order to assess the consistency. It was found that with the exception of Nakhon Phanom (at Thakek) series, there was good consistency between the series. In the case of Nakhon Phanom, since the 1980'ies the data display a pattern that is likely to indicate sedimentation problems in the gauging station area, which affect the discharge-stage relationship and thereby may give incorrect discharges. To compensate for this, an alternative series was calculated for Nakhon Phanom, based on the correlation with Mukdahan/Savannakhet station shortly downstream.

Discharge data from Luang Prabang were available but discarded because it appeared to have an unrealistic increase towards the late 1990'ies, so that discharges were larger than downstream Vientiane. This pattern was rejected as erroneous since it was incompatible with data from other stations. It is likely to be associated with sedimentation at the gauging station.

2.1 Hydrological trends in the Reference period 1950-2000

Historical trends in the hydrological data were investigated in order to project historical hydrological records to the scenario period until 2025. In order to project the historical record most correctly, it is important to establish whether observed trends in the historical records can be expected to continue, or opposite are caused by a series of single once-for-all events, such as large dams and large-scale irrigation schemes. Therefore the trend investigation considered three periods:

- 1925-2000 (i.e. the entire observation period)
- 1925-1970

- 1950-2000.

The second period considered, 1925-70, is a period before the major construction of hydropower dams and large irrigation schemes. Trends found in this period would **not** be a result of dams and irrigation. The third period, 1950-2000, is dominated by the period with intensive expansion of irrigation and hydropower constructions. A comparison of trends in the two sub-periods may indicate to what degree eventual trends are related to such water management constructions.

When considering annual Mekong flows in the entire period **1925-2000**, a decreasing trend is found, see Figure 1. This trend is consistent for the gauging stations downstream Chiang Saen on the Lao-Thai-Burma border, i.e. the four stations in Lao PDR/Thailand. For Chiang Saen however, this trend is not seen, meaning that runoff from Yunnan has been constant.

For the 75 years period the decrease is 13-18% of the average flow at the four stations, which is a significant reduction. At e.g. Pakse, the runoff reduction during these 75 years is from an average flow of 10,700 m³/s in 1925 to 9400 m³/s in 2000, i.e. around 1300 m³/s less. The runoff hydrographs are shown on Figure 1.

The fact that Chiang Saen appear to be stable, indicates that the decreasing runoff is caused by factors located mainly in Laos and/or Thailand. Theoretically, the decreasing runoff might be caused by a decreasing rainfall. It is however assumed as a working hypothesis that the long term rainfall is constant.

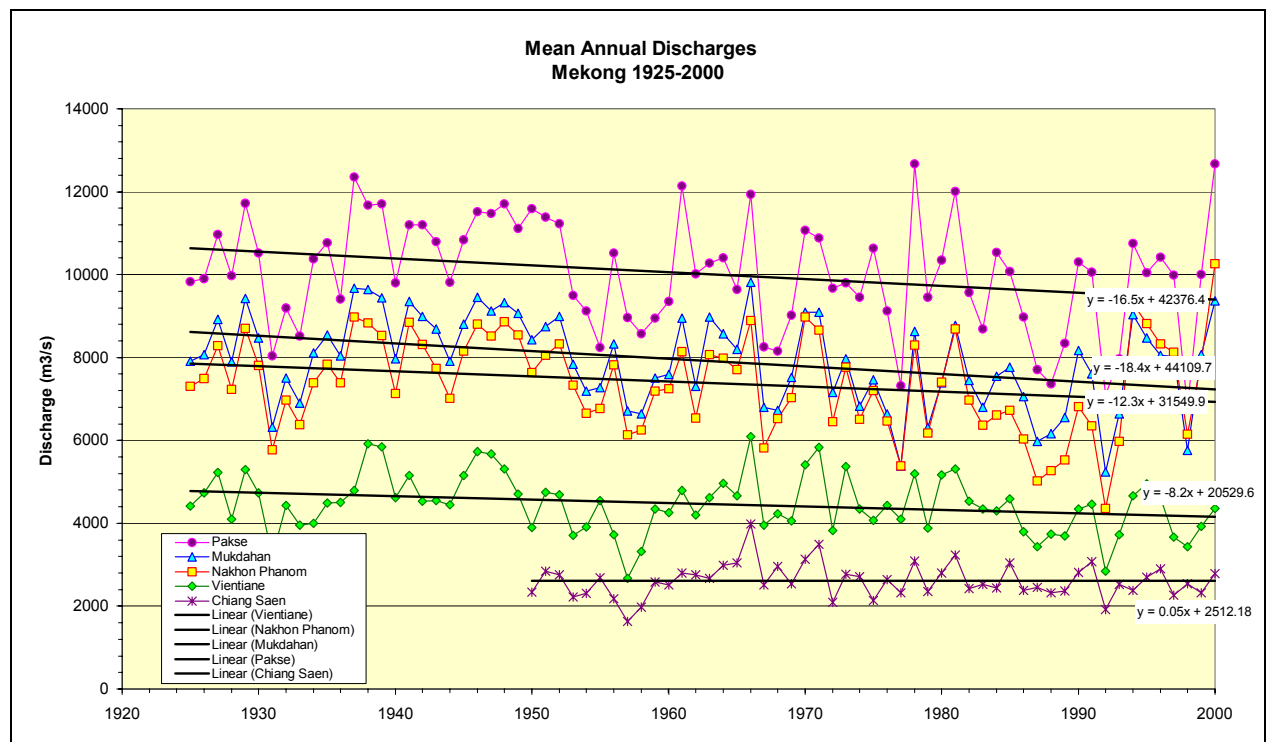


Figure 1 Trends in Mekong Discharges 1925-2000.

When the early sub-period **1925-1970** (45 years) is considered, the decreasing trends are approximately the same as in the entire 75 years period. This sub-period is mainly *before* the construction of large hydropower dams and large irrigation schemes, so it is clear that these constructions cannot be the explanation for the decreasing trend in the early sub-period.

Also the late sub-period **1950-2000** was considered. Again, the trend confirms the trends found from the other periods. The construction of large irrigation schemes was significant in

this period; so if dams and large irrigation had an impact on the annual runoffs, one would expect the trend to be stronger in this sub-period. Since the trends are approximately identical in all periods, it is concluded *that the large water management construction works starting from around 1970 are not the main reason for the decreasing runoff*. It is expected that the cause – if man-made at all - must be found in activities that have been on-going during most of the 20th century.

The conclusion that dams are not the cause to the declining runoffs, can also be evaluated by estimating the possible water consumption from the reservoirs built in the second half of the 20th century. The reservoirs in Thailand have a total surface of around 1000 km², and including Nam Ngum in Lao PDR the total surface area is around 1440 km². Assuming an average evaporation rate of 6 mm/day (or 2 m/year), this water surface can evaporate an equivalent of around 100 m³/s, which is far less than the decrease of 1300 m³/s, which was found for Pakse discharge over the 1925-2000 period.

It should however be noted that the estimated evaporation from reservoir surfaces should be compared with the *natural* evaporation/transpiration from the original land-use prior to dam construction, which would in many cases have been a natural forest. The evapo-transpiration from a natural forest is difficult to estimate accurately and may vary a lot depending on a variety of conditions. However it is important to note that the evapo-transpiration from a forest will often be of approximately same magnitude as an open water surface, due to trees' ability to transpire water from a large leaf area. This is especially true if the forest is evergreen, and thus transpiring also in the dry season. The result of these factors is that the evaporation from reservoirs is likely to differ *less* from the natural pre-dam evapo-transpiration than the above mentioned figure of 100 m³/s. In other words, the figure 100 m³/s as evaporation *introduced by reservoirs* is likely to be exaggerated.

It may be argued that one more important water consuming activity in the Basin is slash-and-burn cultivation. The reason is that the new forest which is regenerating in the fallow areas (which may be 90% of the cultivated area), have a very large water consumption in order to produce maximum biomass, as opposed to mature (say, 30 years old) forest that mainly is surviving and maintaining existence. As shown in the Table 2 below, the forest cover has declined dramatically in Lao PDR, during the last 40 years. Although a large part of the deforestation is due to logging, there is reason to assume that also swidden cultivation has expanded during the reduction of the forest cover. It is therefore possible that deforestation is one of the main factors for explaining the decreasing Mekong flows.

Table 2 Deforestation History and Forecast in Lao PDR in terms Forest Cover (Percentage of he total Surface of Lao PDR).

Period	Forest Cover
Mid 60ies	70 %
Late 80ies	54%
1996	47%
2003	42%
2020	30%

The likelihood of this hypothesis can be evaluated by some simple calculations. According to Table 2, the forest cover has been reduced from 70% to around 45% from the mid-60ies to 2000, i.e. a reduction of 25% of the area of Lao PDR, around 60,000 km². This area should be divided into what has been deforested due to slash-and-burn and what has been deforested due to logging, a distribution that is not well known. It is probably not unrealistic to assume that around one-third of the area is deforested due to slash-and-burn (i.e. around 20,000 km²) and the rest being due to logging.

In the same period the discharge at Pakse has been reduced by around 600 m³/s. These two figures correspond to $600 \text{ m}^3/\text{s} / 20,000 \text{ km}^2 = 1000 \text{ mm}/\text{year} = 2.6 \text{ mm}/\text{day}$. This is a relatively modest water consumption compared to open water evaporation (typically 6 mm/day). It is therefore not difficult to imagine that the observed discharge reduction can be related to the reduction of the forest cover through slash-and-burn.

The above estimations disregarded the water balance of the logged areas. Regrowth in logged areas will to some extent also cause increased water consumption, but the period will be shorter than in slash-and-burn areas, where regular slashing is re-initiating the period with high water consumption. It is however not possible to quantify it more accurately.

In order to reach a firmer conclusion about the reasons for the decreasing Mekong runoff, at least the following should be carried out: 1) a thorough analysis of evapo-transpiration from different forest/vegetation types as well as a study of the actual land-use changes in Lao PDR in the period 1900-2000; and 2) an analysis of long-term trends in rainfall and climate. Such an analysis would have indicated whether the runoff trends were caused by climate changes or rather by land-use changes. This was outside the scope of the CIA study.

2.2 Projected Reference Series

The simulation of hydropower, water balance and hydraulic impacts in Tonle Sap are based on the reference series 1950-2000. It is concluded that mean flows have been declining in the past 50 years or more. It is assumed that this trend will continue. This assumption is based partly on the fact that the processes that have been going on throughout the 20th century are likely to continue (slash-and-burn) for some more decades, even though the Government has a anti-slash-and-burn policy.

A continued declining trend, means that the average discharges in the period 2005-2025 would be around 8% smaller than in the reference period 1950-2000. *The catchment runoffs downstream Yunnan have therefore been reduced by 8%.* The Yunnan runoff has been left unchanged, since no decreasing trend was detected at Chiang Saen. Since the Yunnan runoff was not changed, that leaves the reductions of the Mekong discharges a little less than 8%. The resulting reduction of the Mekong flow at Thakek (Nakhon Phanom), Savannakhet (Mukdahan) and Pakse is around 6%.

3 WATER BALANCE MODELLING

3.1.1 Baseline

Scenario simulations were carried out with the internationally recognised software MikeBasin, which is a *water balance model* for simulation of water allocation, reservoir operation, irrigation and other water uses.

A baseline scenario was established by attributing catchment runoffs to gauging stations at Chiang Saen, Vientiane, Thakek, Savannakhet, Pakse and Kratie. The runoff series were established by subtracting the discharge at the gauging station upstream. For example the runoff series for Pakse was computed as the Pakse discharge minus the Savannakhet discharge.

For Nam Theun at Theun-Hinboun (TH) headpond the runoff series was extended to 50 years by correlating the observed series at Theun-Hinboun with the long Ban Signo series. A similar correlation analysis with respect to Ban Signo was carried out for Mahaxai in Xe Bang Fai to obtain a long baseline series.

The baseline simulation was based on observed/extended monthly discharge series and included the operation of the Theun-Hinboun hydropower diversion. The result of the baseline simulation is a discharge series 1950-2000 which serve as a basis for comparison in the subsequent scenario simulations.

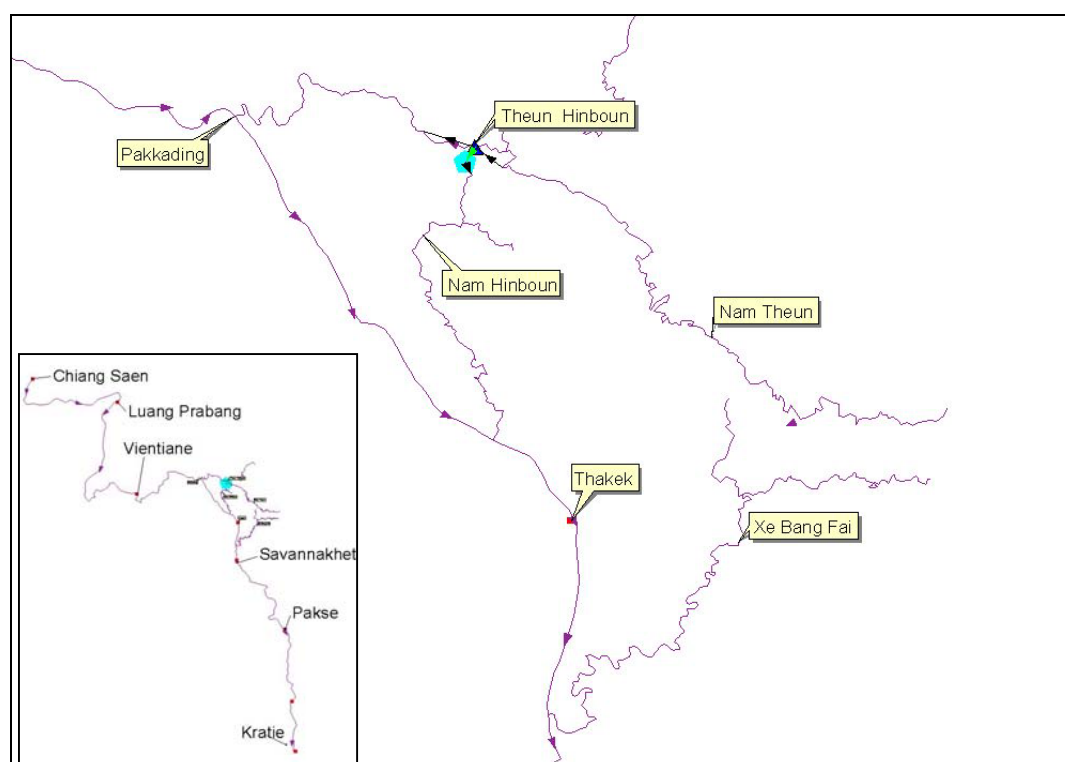


Figure 2 Detail of MikeBasin water balance model for hydrological simulations: The baseline setup simulates only TH hydropower. The little figure shows the entire model area.

3.1.2 NT2 Impacts

The NT2 dam and reservoir were introduced in the MikeBasin model setup, as illustrated schematically in Figure 3. Basic information such as reservoir storage curves, spillway capacity, turbine capacity, operation rules were taken from available documents, predominantly the NT2 EIA documents.

Figure 4 shows the results of reservoir simulation in terms of in-and outflows from/to the NT2 Nakai reservoir. The green curve shows the natural inflow to the reservoir, the dotted red curve shows the diversion through turbines to Xe Bang Fai, which varies from a maximum of 280 m³/s (as an average for a week) to almost zero at the end of the dry season. In a number of years spilling (black curve) occurs during the flood season.

Figure 5 shows again the post-NT2 turbine discharges at TH, but here together with the baseline (pre-NT2) turbine discharge for comparison. The figure illustrates the impact by NT2: during the dry season, the TH diversion (and hence energy production) is heavily reduced, while in the wet season the TH operation is unchanged.

Figure 33 shows the pre- and post-NT2 discharge in Nam Kading just before the Mekong confluence, and it illustrates that the flow reduction is significant. Figure 34 shows the corresponding discharges for Xe Bang Fai at Mahaxai. In this case there is a significant increase of the discharge due to the release from the turbines. The main report presents summary curves of these hydrographs with average, 10% resp. 90% percentiles for each of the year's months.

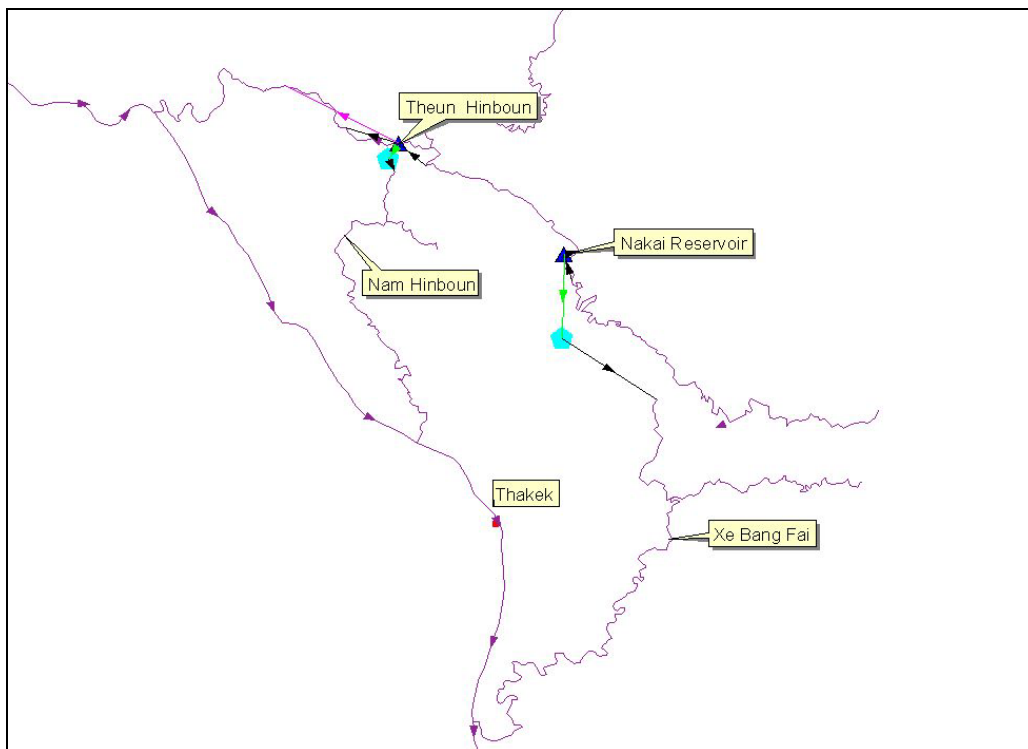


Figure 3 Detail of MikeBasin water balance model for hydrological simulations. Setup for simulation of NT2 operation. Compare with Figure 2.

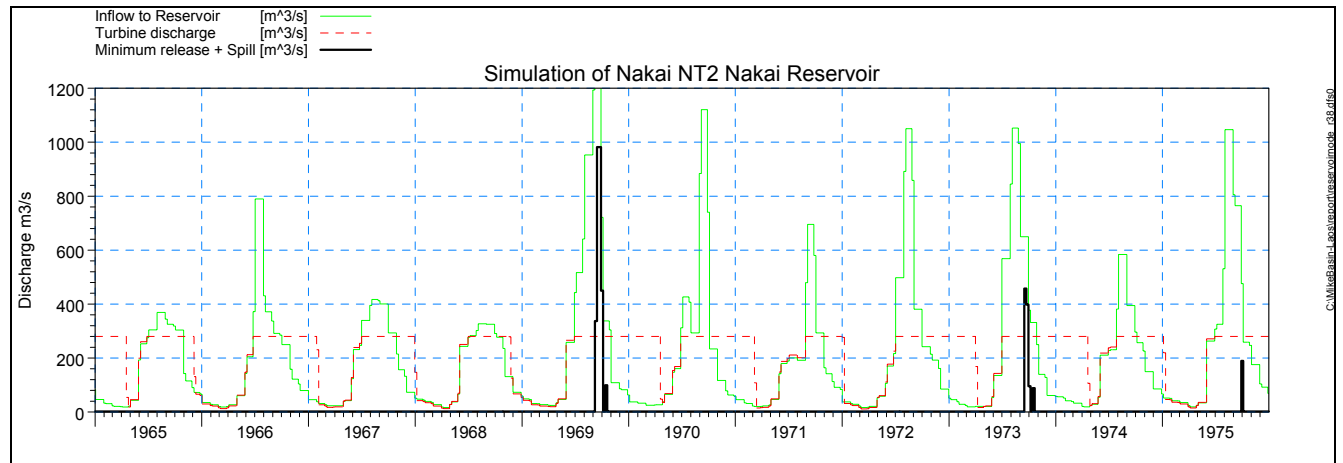


Figure 4 Result of reservoir simulations of NT2: Reservoir inflow, turbine discharge and spills. Weekly average discharges 1950-2000.

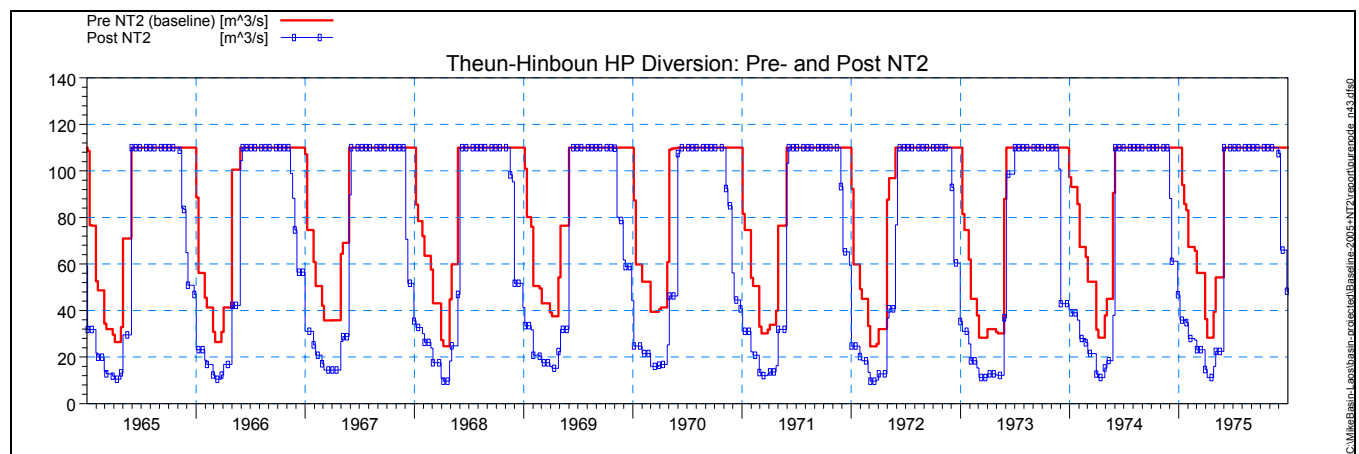


Figure 5 Simulated turbine discharge at Theun-Hinboun HP, pre-NT2 baseline (bold red) and post-NT2 (blue with markers).

3.1.3 Cumulative Impacts

Cumulative impacts 2010 and 2025 include the operation of a number of new hydropower projects. In both cases NT2 is included and simulated like reported above. For other hydropower projects the simulations were carried out separately by sub-basins. Table 3 below shows the reservoirs which constitute the input to the hydrological impact simulations. The table shows the grouping of reservoirs by Mekong sections. The table also shows an aggregate regulation coefficient by section, i.e. the ratio between annual runoff and total active storage in the sub-basin, a coefficient that indicates the degree of seasonal variation. The table shows that the Yunnan part of Mekong will be subject to a large degree (36%) of seasonal regulation in 2025, and that the degree of season variation decreases downstream, due to more unregulated than regulated inflows downstream.

The separate hydropower simulations are reported separately in more detail in Annex 3 and are therefore not commented further here. Figure 6 however shows the result of the hydropower simulations in terms of the change of river discharge for the Yunnan part of the basin. The negative peaks represent reductions of the river discharge, namely as flood control, while the positive less pointy peaks represent increases of the flow, namely during

the dry season. The figure illustrates an input to MikeBasin, similarly as for the Nam Ngum and the Se San/Se Kong/Sre Pok basins.

Figure 7 shows the result from the MikeBasin water balance simulations: the regulated discharge at Kratie, in the two scenarios 2010 and 2025, as well as baseline for comparison.

Table 3 Overview of planned reservoirs in the Mekong Basin, as input to hydrological simulations. Grouped by river sections..

Mekong section	Project	Country	Active storage (mill. m ³ /yr.)		Flow Mekong (mill. m ³ /yr.)	Overall Regulation coefficient	
			2010	2025		2010	2025
Upper Mekong (Yunnan)	Manwan	China	257	257			
	Dachaoshan	China	367	367			
	Xiaowan	China	9,900	9,900			
	Gonguoqiao	China		120			
	Jinghong	China		249			
	Nuozhadu	China		12,300			
	Mengsong	China		-			
	Ganlanba	China		-			
	SUM		10,524	23,193	64,000	16%	36%
China border to Pak Kading	Nam Leuk	Lao PDR	123	123			
	Nam Lik	Lao PDR	826	826			
	Nam Ngum 3E	Lao PDR		983			
	Nam Ngum 2B	Lao PDR		150			
	Nam Ngum 5	Lao PDR		252			
	Nam Ngum 4A	Lao PDR		337			
	Nam Bak 2B	Lao PDR		119			
		Section Sum		949	2,790		
	ACCUM. SUM		11,473	25,983	187,000	6%	14%
Pak Kading to Pakse	Nam Theun 2	Lao PDR	3,510	3,510			
	Theun Hinboun Ext.	Lao PDR	2,870	2,870			
		Section Sum	6,380	6,380			
	ACCUM. SUM	17,853	32,363	289,000	6%	11%	
Pakse to Outlet/Delta	Huoay Ho	Lao PDR	480	480			
	Xepon	Lao PDR	361	361			
	Xe Kaman 3	Lao PDR		108			
	Xe Kaman 1	Lao PDR		3,340			
	Xe Kong 5	Lao PDR		2,210			
	Nam Kong 3	Lao PDR		299			
	Xe Xou	Lao PDR		1,710			
	Yali	Vietnam	779	779			
	U. Kontum	Vietnam		123			
	Pleikrong	Vietnam		1,022			
	Se San 4	Vietnam		470			
	D Xuyen	Vietnam		484			
	Ban Tou Srah	Vietnam		483			
	Lower Se San 2D	Cambodia		NA			
	Lower Se San 2U	Cambodia		NA			
	Lower Sre Pok 2	Cambodia		NA			
	Section Sum		1,620	11,869			
	ACCUM. SUM		19,473	44,232	460,000	4%	10%

NA=Not available

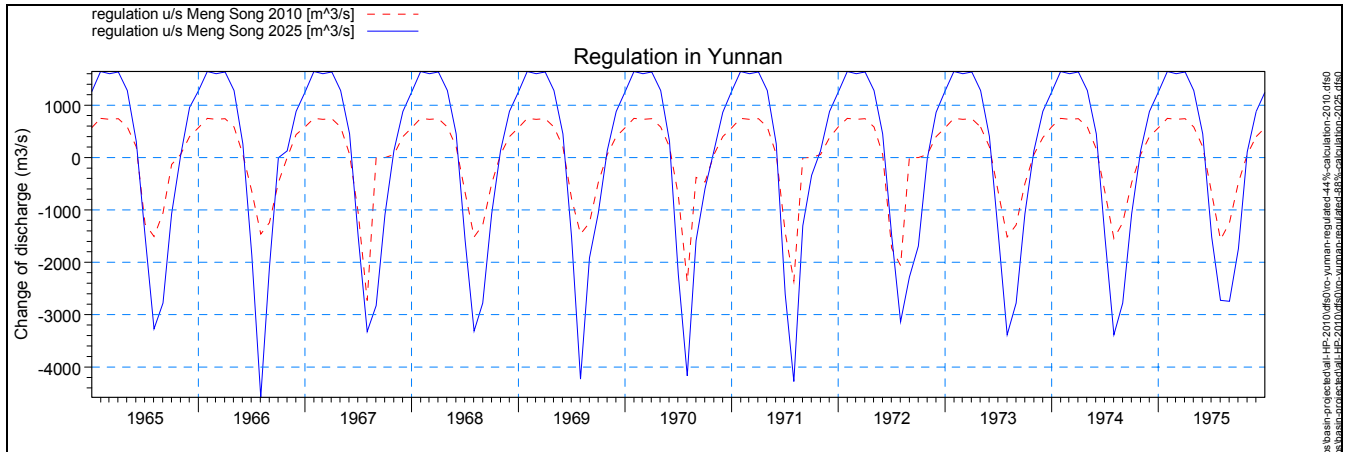


Figure 6 Input to MikeBasin water balance calculation: Regulation in Yunnan (2010 and 2025), as a result of hydropower simulations.

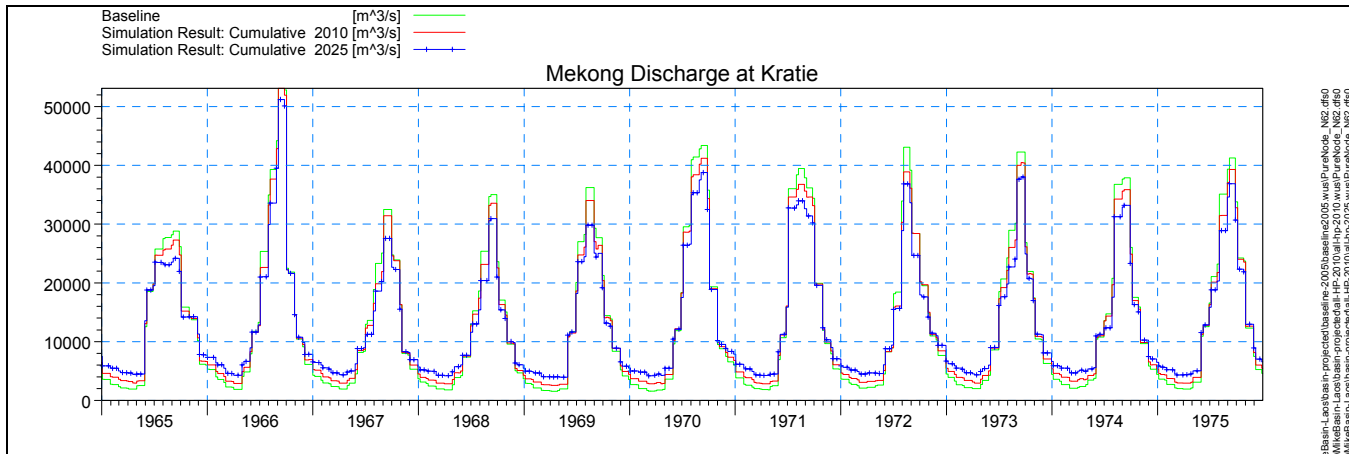


Figure 7 Result output from MikeBasin water balance simulations: Mekong Discharge at Kratie – baseline and regulated (cumulative 2010 and 2025).

4 HYDRAULIC MODELLING

4.1 General Set-up

Mathematical modelling for the hydraulics of the Mekong River system in Cambodia was undertaken in order to evaluate the impacts on the Tonle Sap system. A one-dimensional river and flood plain model (MIKE11) has been established for the Cambodian part of the Mekong, including the Mekong mainstream, Tonle Sap River and Great Lake, the Bassac River that runs in parallel with Mekong from Phnom Penh, and a simplified set-up of the Mekong Delta in Vietnam. The model area covers the Mekong River from Kratie in Cambodia to the outlet in the South China Sea through the Delta. Thus, the model includes a river length of around 500 km along Mekong from Kratie to the Sea. In addition the model includes 230 km in the Tonle Sap river and lake system.

The very complex hydraulics in the Delta are simulated in a quite simplistic way, since it is not the scope to provide detailed simulation results for the Delta itself. Therefore only five main rivers branches from the delta were included, while a set-up with eight main branches would have been more correct. The model was calibrated with respect to gauging stations (both water levels and discharges) around the Mekong/Tonle Sap confluence. Thus, the main effort was focused on obtaining a realistic model in central Cambodia rather than in the Delta.

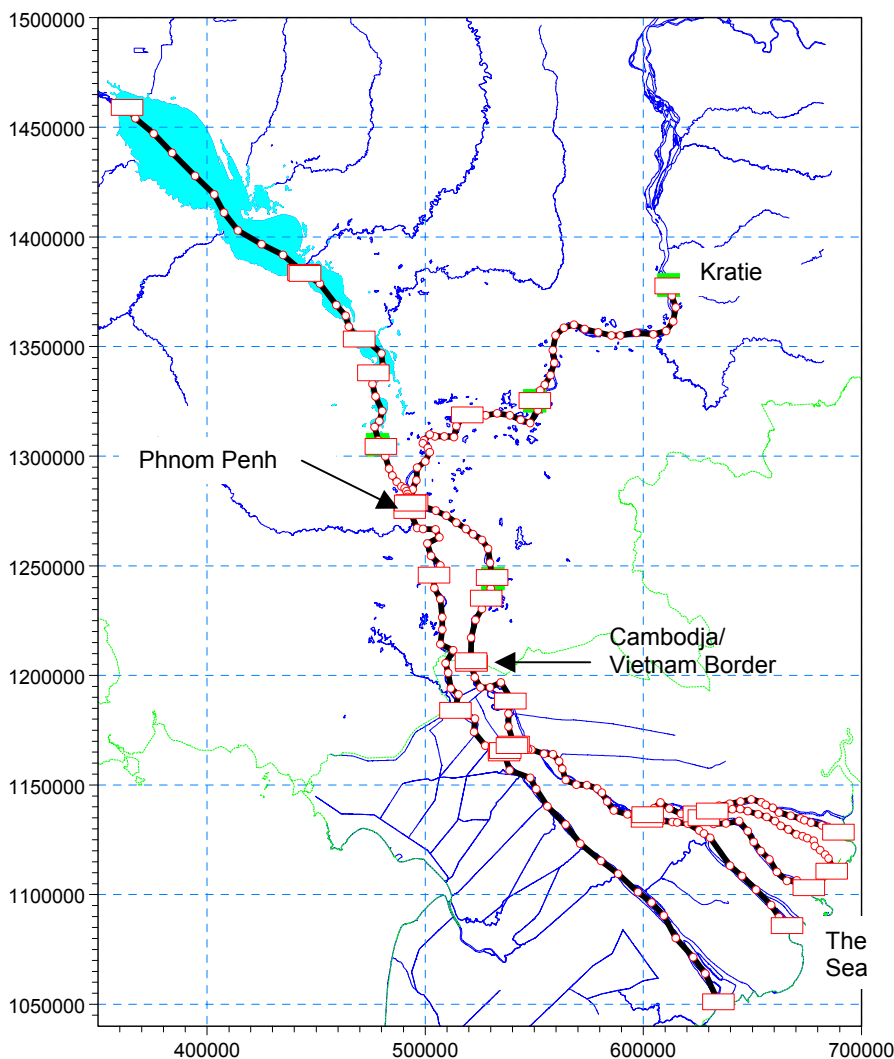


Figure 8 Schematic view of the hydraulic model of the Tonle Sap and Mekong Delta.

4.2 Input Data

The upstream boundary condition (i.e. input information) is observed discharges at Kratie in the baseline simulation. In the scenario simulation (NT2 impacts and 2025 cumulative impacts), the upstream boundary is the corresponding scenario discharge at Kratie, as calculated for the middle Mekong Basin.

The downstream boundary condition (i.e. input time series at the downstream model end) is the sea level of the South China Sea, with tidal variation. The variations of sea levels and tidal amplitudes over the year were provided by WUP-JICA (2003). The tidal amplitude is more than 3m (i.e. +/-1.5m), and the tidal variations can be observed as far upstream as Phnom Penh, 330 km from the Sea (+/- 0.15m). The true tidal movement is rather complex, with different superimposed oscillations with different periods. In this model, a simplified tidal movement was applied, with a constant tide pattern throughout a month. The tidal patterns are seen on the simulation results shown on Figure 30.

Topographic information (river cross-sections) was available on the Internet home page of the Mekong River Commission (MRC) for a number of locations. Cross section locations are indicated on Figure 8 as small rectangles. A number of example cross sections are shown as Figure 28. In addition to the explicit cross section information from the MRC homepage, additional topographic information was available in WUP-JICA (2003), in terms of general descriptions of major morphological features of the Delta.

Floodplain storage is an important feature in the Tonle Sap/Delta area, i.e. the storage of large volumes outside the ordinary river profile during floods. Tonle Sap Lake is the most important of such storages, but also along Mekong and Bassac further downstream there are large floodplains. Realistic amounts of floodplain storage were estimated by inspecting inundation maps and comparing with simultaneous water level observation. Figure 29 shows the inundation on the 30. August 2001 (water level at Prek Kdam in Tonle Sap river 9.3 m (see Figure 9)).

Concerning the storage volume of Tonle Sap Lake, a relationship between lake area and lake level has been developed by Tes (1998). In a very comprehensive study, CTI/DHI (2003) have established a detailed storage curve, which gives somewhat larger areas than Tes' curve, which is apparently because the former (CTI/DHI) considers a larger area in the curve. In this study, the areas by Tes were attributed to the cross-sections in the lake itself, while additional areas (estimated by studying inundation maps) were attributed to cross-sections in the Tonle Sap River. It is therefore estimated that *total* areas included in this model are in correspondence with the CTI/DHI figures.

4.3 Calibration

Observed water levels and discharge were available for three gauging stations in the crucial Mekong/Tonle Sap confluence area at Phnom Penh. The locations of the three stations are shown on Figure 9. The stations are Kompong Cham on the Mekong upstream the Tonle Sap confluence, Prek Kdam in the Tonle Sap river and Neak Luong on the Mekong downstream Phnom Penh, i.e. after the division into Mekong and Bassac.

The model was calibrated by adjusting the roughness coefficient (the Manning number), flood plain storage and in some cases the cross-section profiles, in order to achieve a good correspondence between observed and simulated water levels and discharges. Since the topographical information in the model is relative scarce and therefore left quite large gaps, it was considered acceptable to do modifications to the information that was more an estimate than a result of measurements.

Figure 31 shows the result of the calibration, in terms of a good fit between observed (coloured markers) and simulated (black) water levels in the Tonle Sap river at Prek Kdam gauging station, which is a key location. There are only insignificant differences, and the maximum water levels are correctly simulated. This is especially important, because the water levels at this location are closely related to the Lake water level. The lower figure of Figure 31 shows the discharges at the same station. The above-zero part of the curve signifies flow from the Lake to the Mekong, while the below-zero part of the hydrographs signifies the reverse flow during the early flood season, while the Mekong rises. It should be noted that the below-zero part of the curve has good correspondence to observed discharges. Also the time of flow reverse (when the discharges rapidly change from negative to positive) is correctly simulated. However the period with flood recession has less good correspondence, i.e. the above-zero part of the hydrograph. This is the late flood season when the Mekong is receding and the Lake is being emptied. The peak of the above-zero hydrograph limb is the moment when the gradient between the Lake and the Mekong is at its largest, i.e. when the Mekong level is rapidly decreasing. The maximum water level in the Lake however occurs when the flow reverses, so it is considered less significant that the discharge out of the Lake is not quite in agreement with the observation.

Figure 32 (upper graph) shows simulated and observed discharges in the Mekong at Neak Luong, downstream Phnom Penh, i.e. where the flow has been divided between Mekong and Bassac. Simulated discharges are in good correspondence with the observed ones, however mostly on the rising limb of the hydrograph, i.e. in the early and maximum flood season.

The lower graph of Figure 32 shows observed and simulated water levels in the Mekong at Kampong Cham, upstream Phnom Penh. The correspondence is very good.

It is concluded that as a result of the calibration, the model simulates the water levels and discharges in the Meong/Tonle Sap system in a realistic way, which is satisfactory for simulating the impacts of upstream water use.



Figure 9 Location of gauging stations used for calibration (triangles).

4.4 Baseline Simulations

Daily lake levels are simulated for the period 1960-2002. As shown on Figure 10, annual maximum lake levels vary from 7.5 masl to 10.1 masl, with exception of two drought years 1988 and 1998, in which the Lake only rose to 6.8 and 6.6 masl respectively. Figure 11 compares the simulated Lake levels with the water level at the Mekong/Tonle Sap confluence. During the early flood period, the water levels are lower in the Lake, which is the reason for the flow into the Lake. Correspondingly, during the flow recession, the water level is higher in the Lake, which is reason for the reversed flow that empties the Lake. Small peaks in the Mekong are not reflected in the Lake levels, due to the Lake's large dampening effect. The annual *maximum* water level in the Lake is frequently identical to the maximum level at the Tonle Sap/Mekong confluence, or slightly lower. Figure 12 and Figure 13 show longitudinal profiles of the simulated water level, illustrating the water flow into, respectively out of the lake at different times.

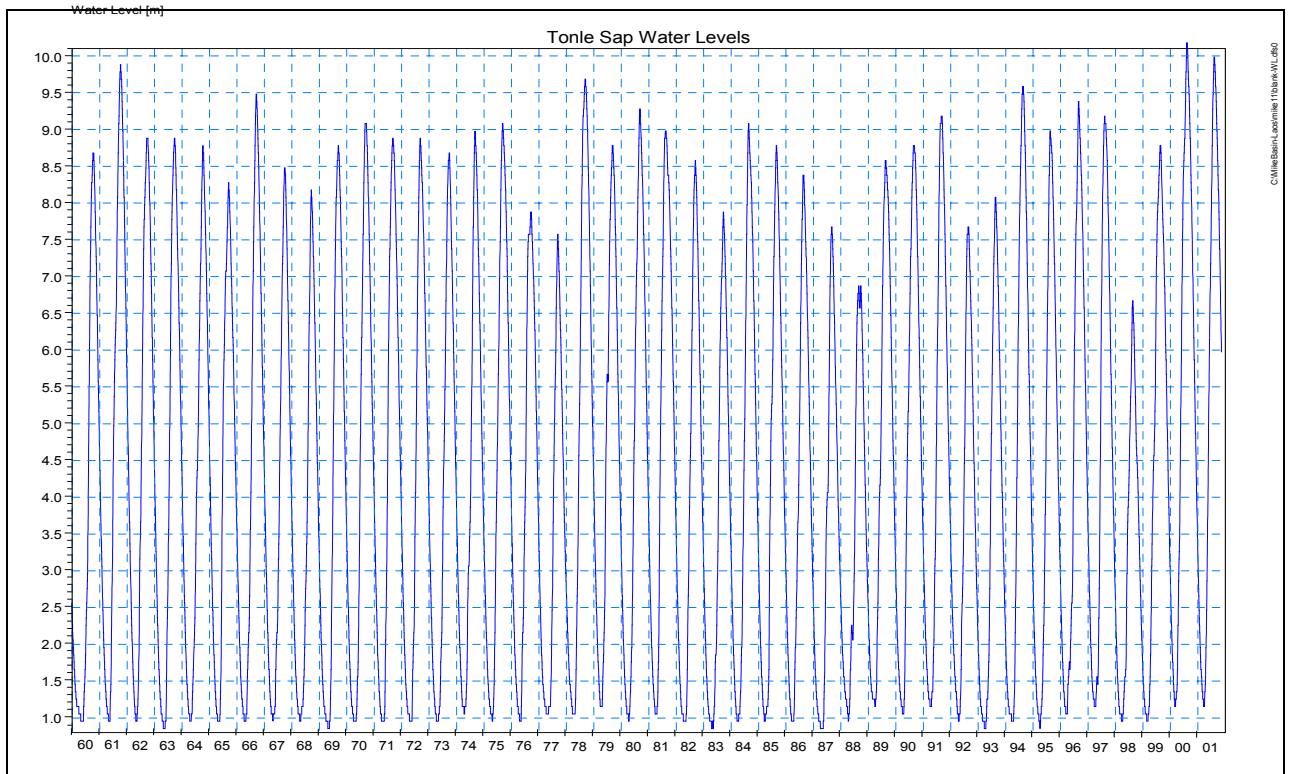


Figure 10 Simulated daily water level in Tonle Sap Lake 1960-2001 (Baseline).

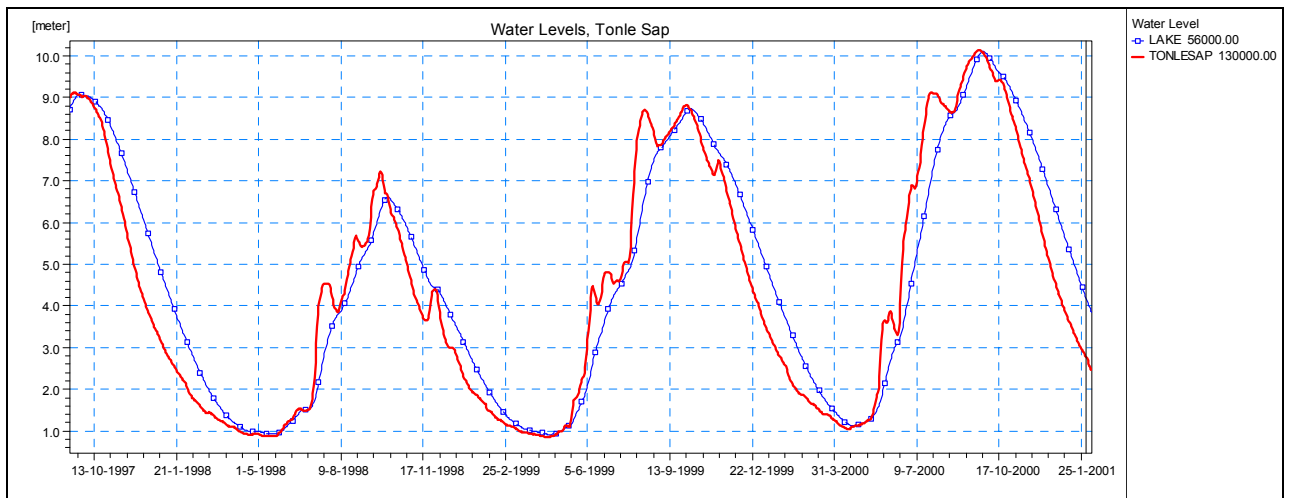


Figure 11 Simulated water level in Tonle Sap Lake (blue with markers) and at Mekong/Tonle Sap confluence at Phnom Penh (bold red). Baseline situation.

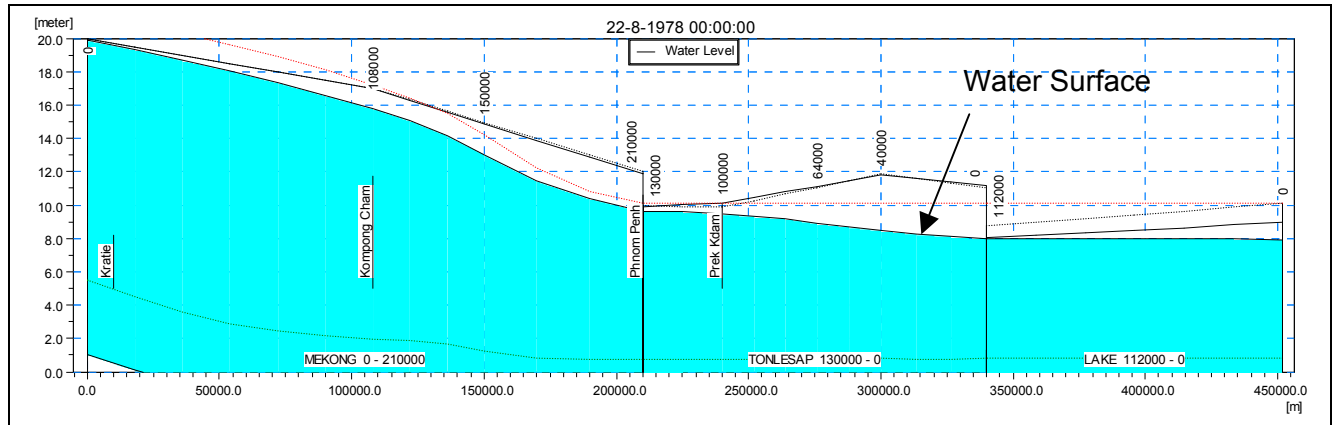


Figure 12 Longitudinal profile from Mekong upstream, through Tonle Sap river to the Lake. Simulated water level during rising floods (August): Water is filling into Tonle Sap.

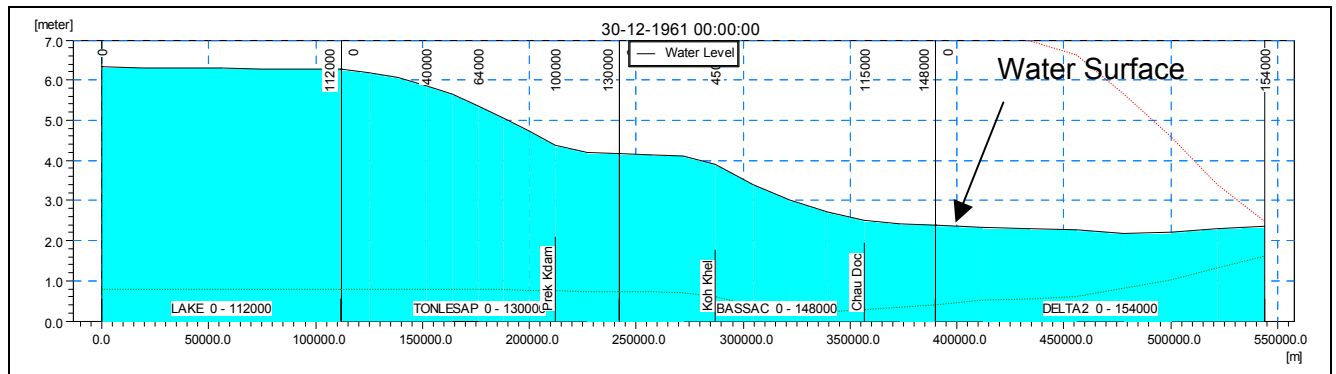


Figure 13 Longitudinal profile from Tonle Sap Lake trough Tonle Sap river, Bassac to the Delta. Simulated water level during flood recession (December): Water is draining out of the Lake.

4.5 Scenario Simulations

4.5.1 NT2 Impact Simulations

The NT2 impacts on the Tonle Sap system were simulated by substituting the Kratie input hydrograph from baseline to the post-NT2 hydrograph for Kratie. Figure 14 shows the Kratie hydrographs for the baseline situation and for the post-NT2 situation. The latter is the result of simulations with MikeBasin, as accounted for in Section 3.1.2. Only a small time window is shown in order to make the difference more visible, since the difference is very small in proportion to the actual discharge.

Figure 15 shows the simulated post-NT2 water levels in Tonle Sap. For clarity, only a three-year time window is shown. Figure 16 below shows the difference between the post-NT2 water levels and the baseline situation, i.e. the net impact due to NT2. It is seen that in September 1969, when the water level peaks at around 7.5 masl, there is a water level reduction of 8 cm due to NT2. The following two years, the reduction of the maximum water level are smaller, only 5 and 3 respectively. Figure 35 shows the difference for the entire 50 years simulation period. It is seen that there is a very large variation of the impact from year to year.

Figure 17 shows a summary plot of the NT2 impact on the lake level. The figure shows, that in September, the mean reduction of the lake level will be 3-4 cm. In 10 % of the years however, the reduction may exceed 6 cm.

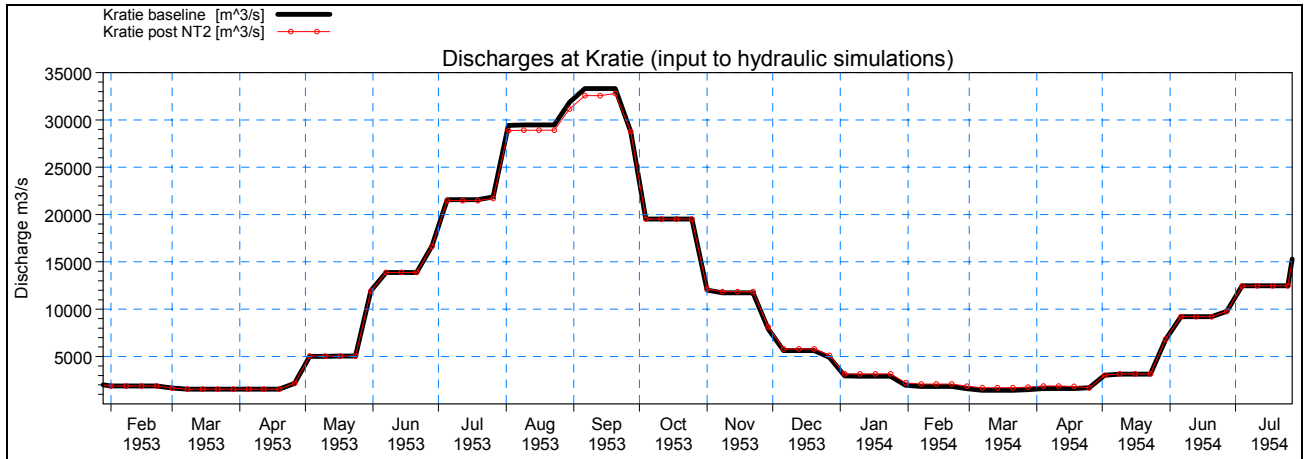


Figure 14 Input to hydraulic simulations, discharge at Kratie. Baseline and post-NT2

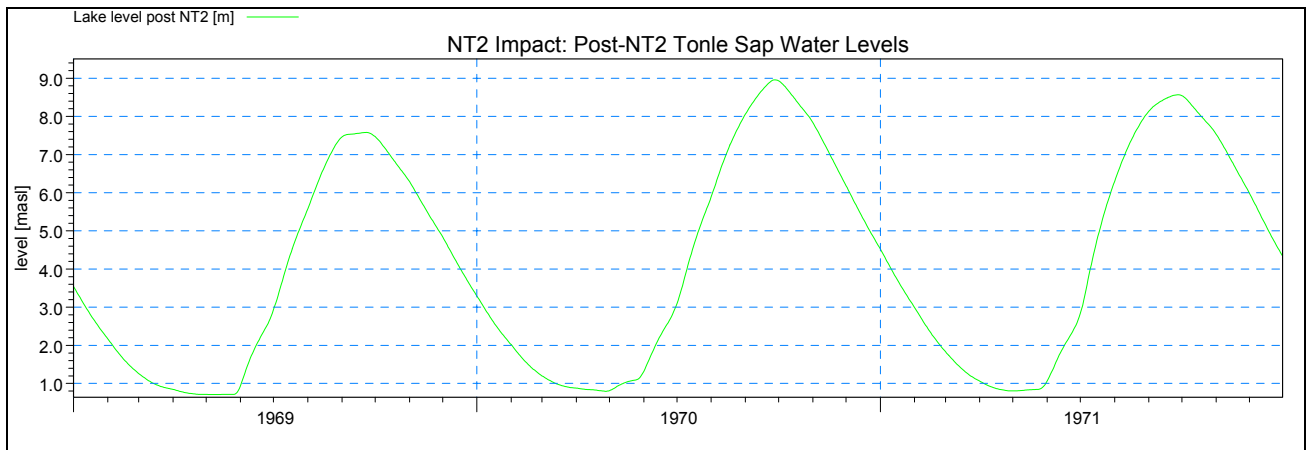


Figure 15 Daily Simulated Tonle Sap water level: Post-NT2.

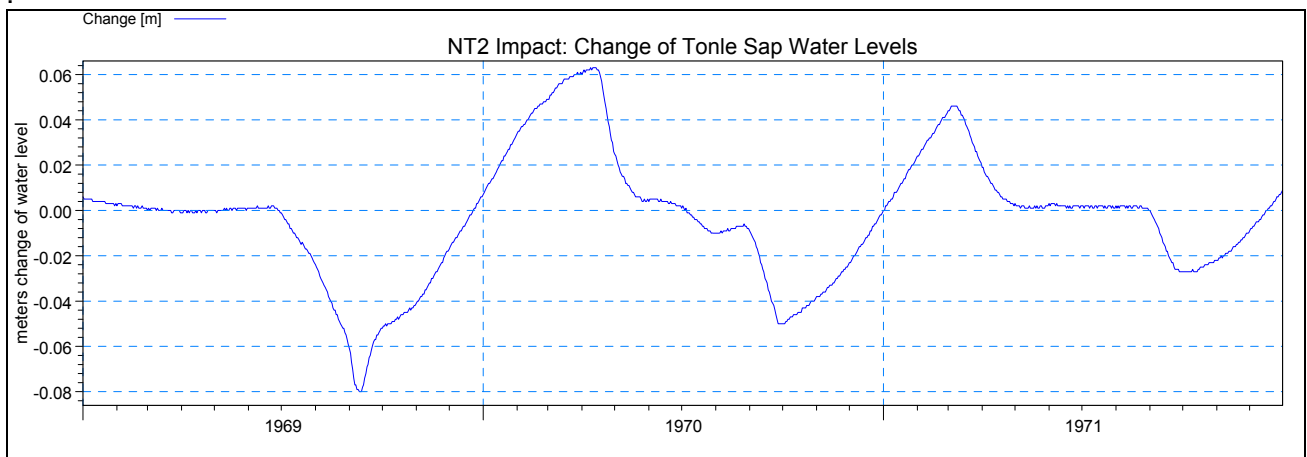


Figure 16 NT2 impact on Tonle Sap lake levels: Simulated change of lake level (post-NT2 minus baseline). Negative figures means reduced level. Should be related to Figure 15.

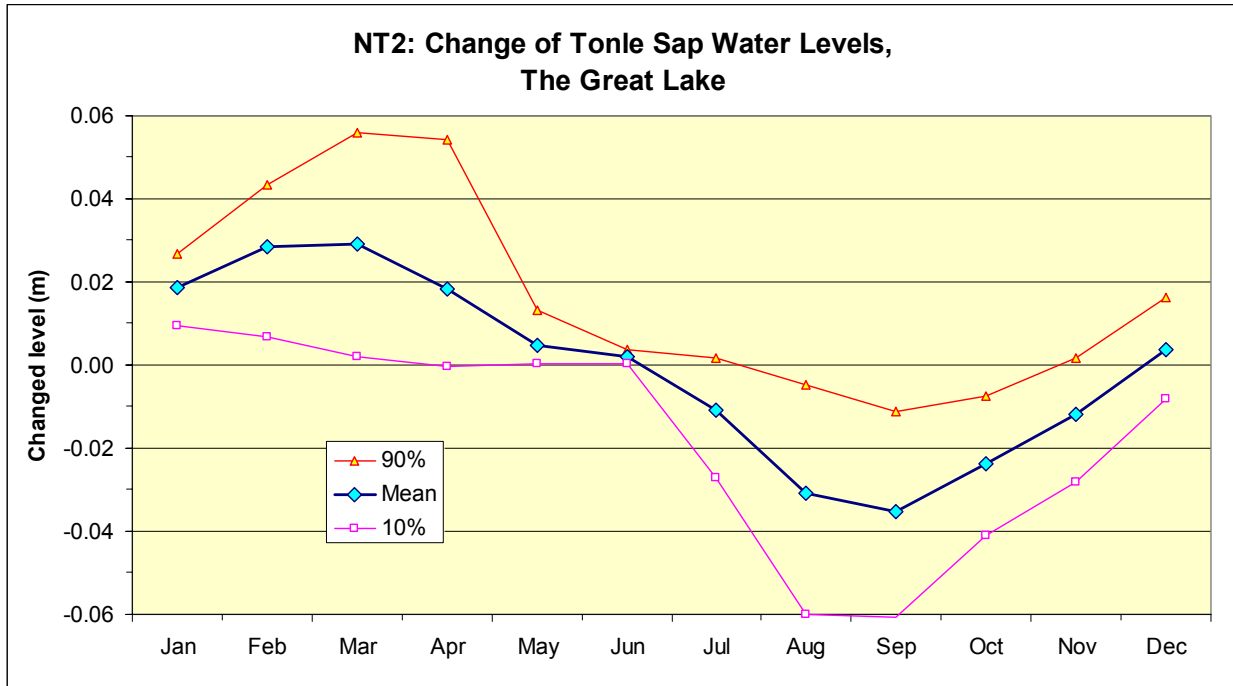


Figure 17 Summary of simulations 1950-2000 of NT2 impacts on Tonle Sap lake levels. Mean, 10% and 90% percentiles of 50 years of simulations.

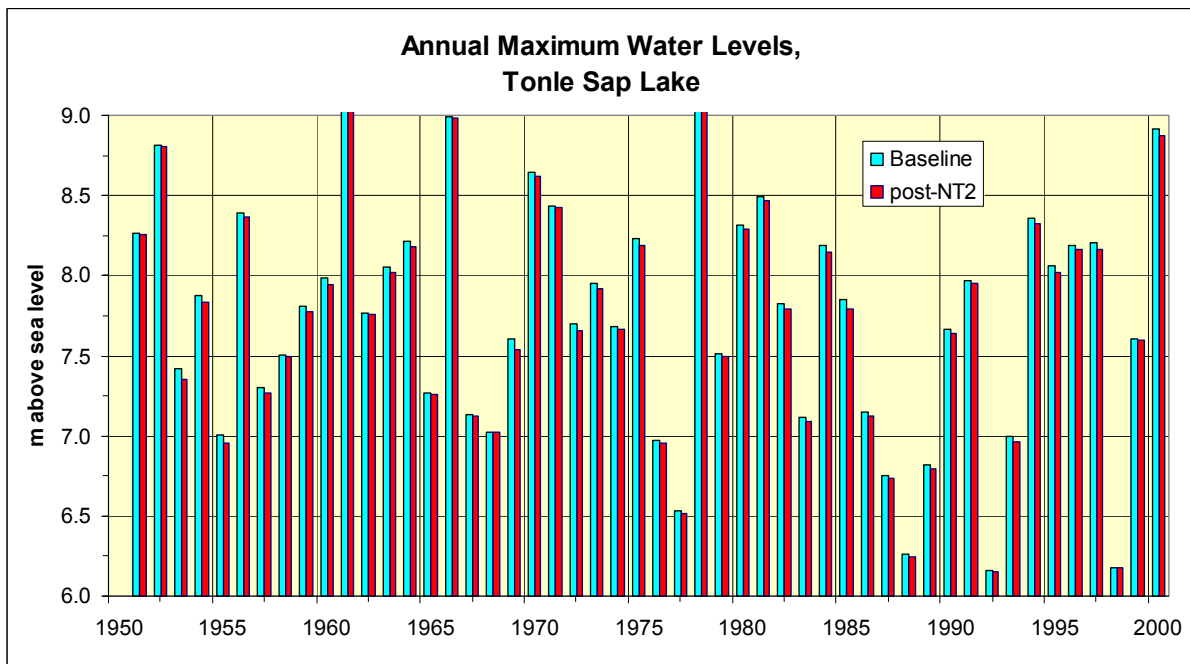


Figure 18 Annual Maximum Water Level, Tonle Sap. Baseline and post-NT2.

4.5.2 Cumulative Impacts 2010 and 2025

Input to the hydraulic simulations were the results from the MikeBasin water balance simulations in terms of the discharge at Kratie, which is shown as Figure 19. The hydraulic model simulated the response of the Tonle Sap/Mekong system due to the changed upstream conditions. The resulting simulated water levels of Tonle Sap are shown as Figure 20 for a three-years time window together with the baseline simulation.

As a summary of the simulation results, Figure 21 shows the impact variation over the average year of the 50 years of simulations. The annual maximum lake level (October-September) is reduced by around 20-25 cm in 2010 and by 55-60 cm in 2025. It should be noted that the impacts are largest in September, but the lake level is highest more often in October than in September.

Table 4 gives a summary of the most essential impacts as results of NT2, Cumulative Impacts 2010 and 2025, respectively.

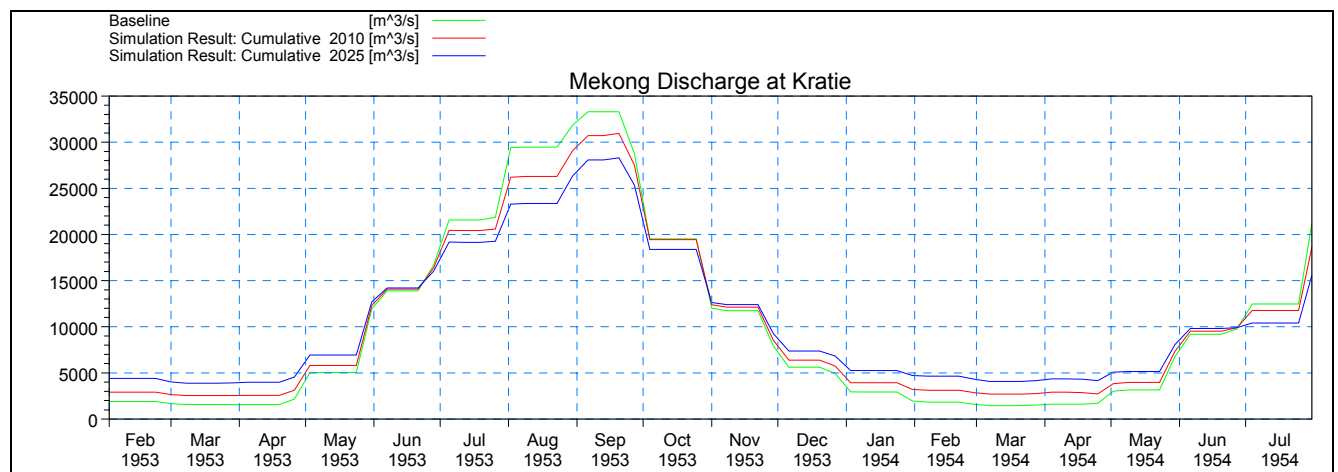


Figure 19 Input to hydraulic simulations: Discharge at Kratie as a result of cumulative impacts 2010 and 2025.

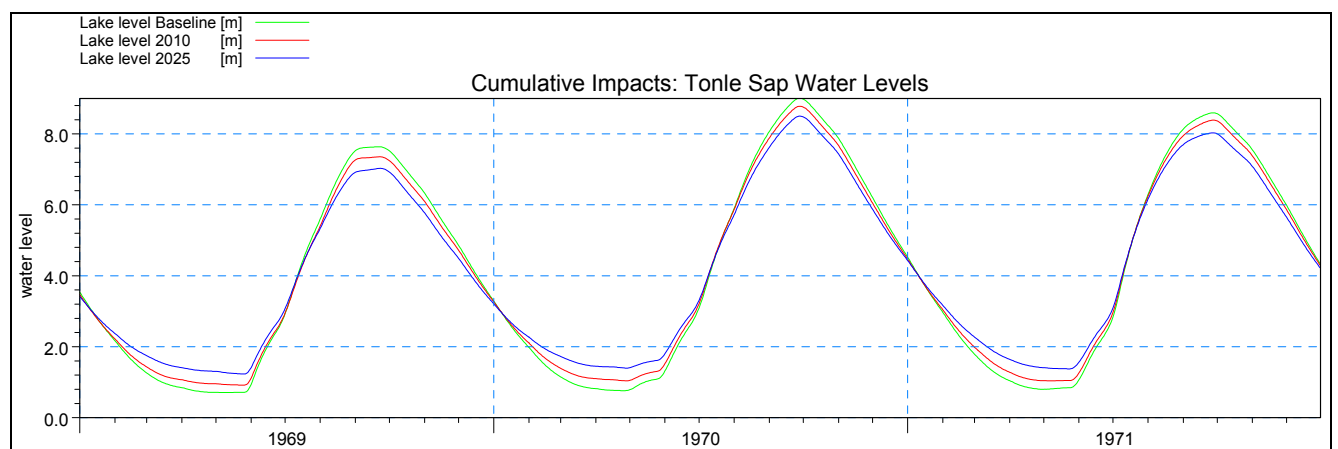


Figure 20 Simulated Tonle Sap water levels: Cumulative Impacts 2010 and 2025.

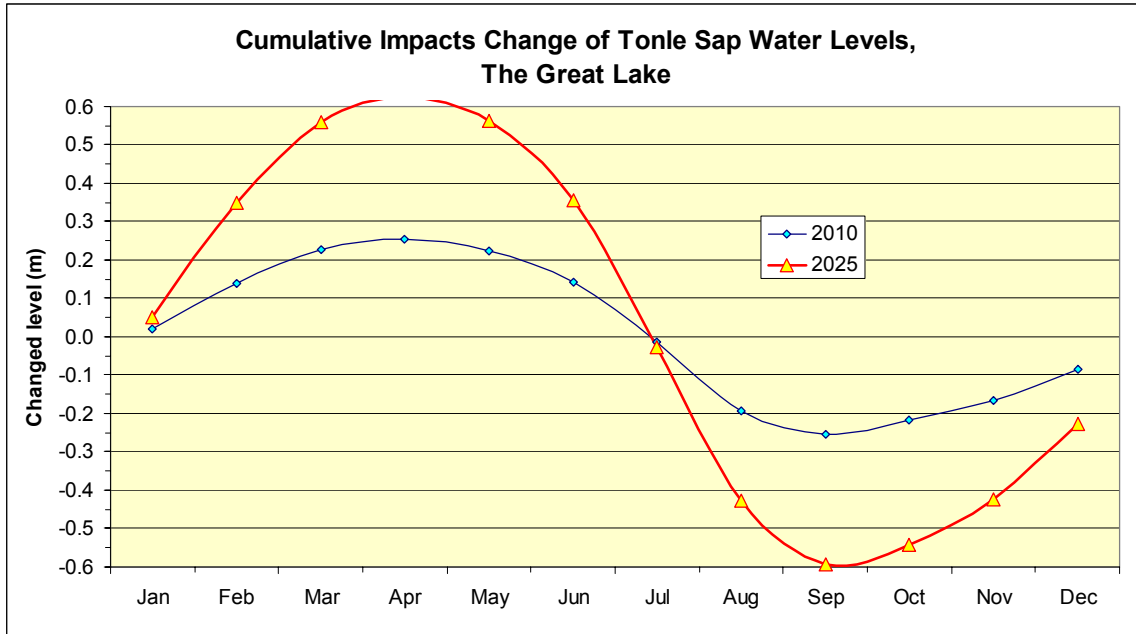


Figure 21 Change of Tonle Sap water level. Average of entire 50 years simulation period, 2010 and 2025 Cumulative Impacts.

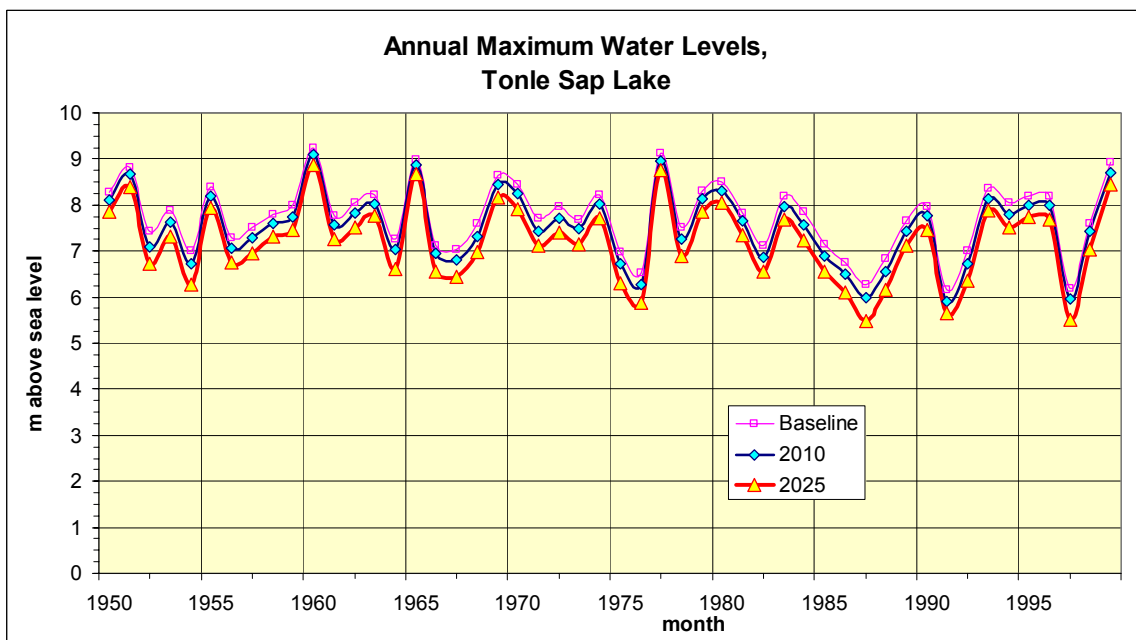


Figure 22 Annual Maximum Water Level in Tonle Sap (September or October). Baseline, 2010 and 2025 Cumulative Impacts.

Table 4 Summary of key simulation results for impacts on Tonle Sap Lake: Wet Season

	Average Annual Maximum Q at Kratie	Discharge Change	Average Annual Maximum Lake Level	Level Change	Average Annual Maximum Lake Area	Area Change
	[m ³ /s]	[%]	[masl]	[cm]	[km ²]	[km ²]
Baseline	35,250		7.64		9895	
Post-NT2	35,050	-0.6%	7.61	-3 cm	9855	-40 km ²
CIA 2010	33,565	-5%	7.42	-22 cm	9540	-355 km ²
CIA 2025	31,020	-17%	7.10	-54 cm	9030	-865 km ²

Table 5 Summary of key simulation results for impacts on Tonle Sap Lake: Dry Season.

	Average Annual Minimum Q at Kratie	Discharge Change	Average Annual Minimum Lake Level	Level Change	Average Annual Minimum Lake Area	Area Change
	[m ³ /s]	[%]	[masl]	[cm]	[km ²]	[km ²]
Baseline	2000		0.89		2410	
Post-NT2	2040	+2%	0.91	+2 cm	2420	+10 km ²
CIA 2010	3050	+53%	1.14	+25 cm	2555	+145 km ²
CIA 2025	4470	+124%	1.52	+63 cm	2785	+375 km ²

4.5.3 Impacts in the Delta

In the present baseline situation, saltwater intrusion is an important problem in the Delta. The mechanism that is causing saltwater intrusion is the combination of an extremely low gradient through the Delta, i.e. for around 300 km from the Sea, and the rather high tidal amplitudes, namely around 3m (+/- 1.5m). When discharges are small in the dry season, the high tides cause an inflow of seawater into the rivers. The tidal oscillations are measured as far upstream as Phnom Penh, although the saltwater itself does not propagate so far upstream. Flow reversal, i.e. flow going upstream, occurs as far upstream as Tan Chau and Chau Doc close to the Vietnamese/Cambodian border. Figure 23 below shows observed discharges at Tan Chau and downstream and illustrates the frequent occurrence of negative flows at My Thuan.

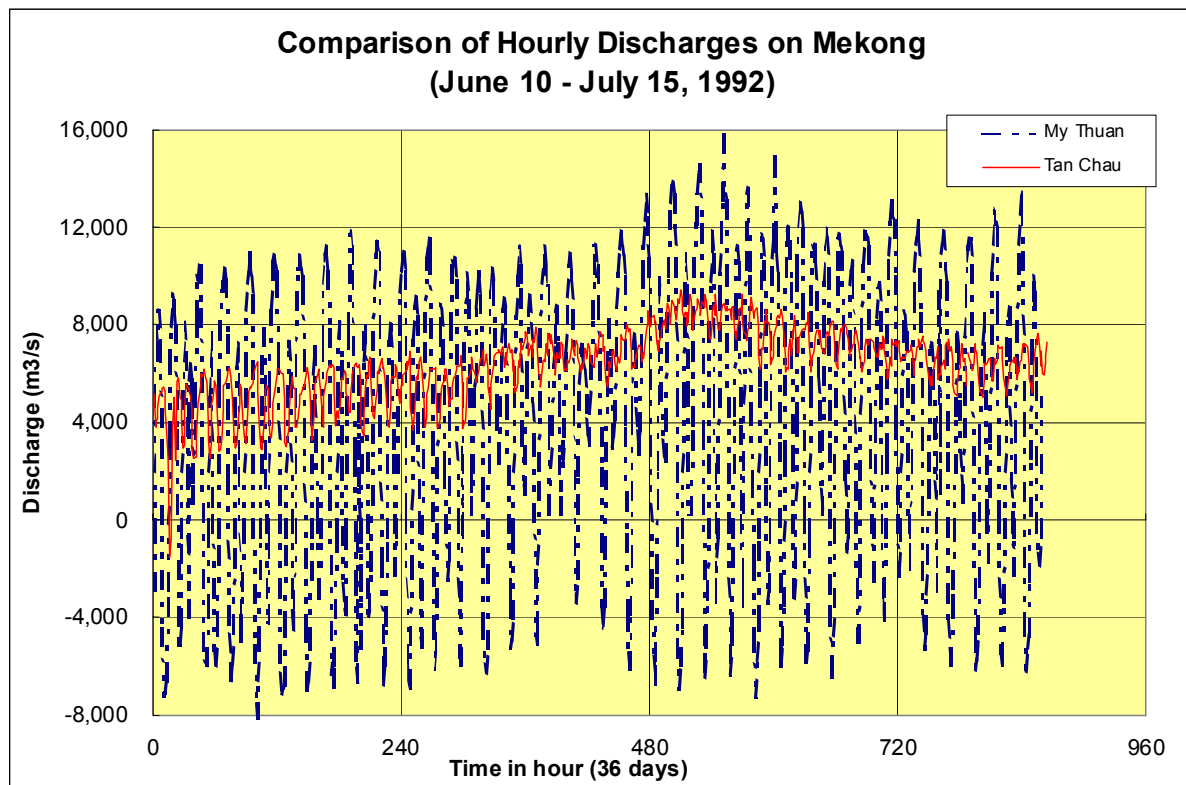


Figure 23 Observed Mekong discharges under tidal influence. Stations Tan Chau at Cambodian/Vietnamese border and my Thuan 90km further downstream. Source:WUP-JICA 2003.

Due to the regulation by hydropower, river discharges through the Delta are increased in the dry season. The increased dry season discharge reduces saltwater intrusion. The results from the hydraulic modelling are used to quantify the reduction of saltwater intrusion. It should be noted that the model is somewhat simplified in the Delta, by reducing the large number of parallel river branches to five model river branches. The results should therefore be considered as indicative. The main focus is however the *difference* between baseline and scenario simulation, and it is believed that the inaccuracy in the difference, i.e. *net* impact, is less significant.

Figure 24 below shows the tidal discharge variations in an example time interval in the dry season, when seawater intrusion is significant (large negative discharges). The location is at the beginning of the Delta. The figure shows simulated river discharges at 6 hour intervals, thus illustrating the in- and outflow of seawater in terms of negative, resp. positive discharges. In the shown example, discharges are above 4500 m³/s in 3 out 4 timesteps (18

of 24 hours) every day, but in one time step (6 hours interval) the discharges are negative and between 1000 and 2000 m³/s most of the time.

Concerning the impact of NT2, the figure shows that the generally increased dry-season flow which is a result of the regulation, generally “lifts” the NT2 curve. This implies that the negative discharges become “less negative”. In other words the seawater intrusion is reduced. In the shown example, the inflow is reduced by approximately 300 m³/s. The change of the negative flows is outlined by the distance between the two envelope curves through the lowest marker points for the two simulations (baseline and post-NT2, resp.).

The above example was presented as an illustration. At other times of the year, the impact may be different. Therefore a more representative way to assess the impact, is by looking at duration curves, i.e. the relation between a discharge value and the proportion of time that flows are smaller than that value. By inspecting the value zero, the duration curve yields the proportion of time with negative flows, i.e. seawater intrusion. The impact on saltwater intrusion by scenarios can be expressed as a *changed duration* of negative flows.

Figure 25 shows the Flow Duration Curve computed for Tan Chau at the beginning of the Delta at the Cambodian/Vietnamese boundary. The input data to each curve are the discharge time series simulated for a 50 years period (1950-2000) with 6 hours time step. The figure however only shows part of the curve for discharges below 6,000 m³/s, i.e. dry season flows. It is clearly visible that more drastic scenarios have more impact in terms of increasing the discharges (in the dry season) and correspondingly, reducing the duration of time with negative discharges.

For a closer look at the impact on seawater intrusion, Figure 26 provides a zoom to the smallest and negative discharges. The Baseline duration curve (bold) crosses the Q=0 m³/s horizontal line at 9.5%, i.e. in the baseline situation, the flow direction is upstream in 9.5% of time. The Post-NT2 curve (located closely to the left of the Baseline curve) intersects the zero line at 9.3%. This means that negative discharges occur 2% less time. This is a beneficial impact, although marginal.

For the two Cumulative Scenarios, the impacts are seen more easily. As shown by Figure 26, the duration curve for the 2010 scenario intersects the Q=0 m³/s at 8.4% and for the 2025 scenario at 6.1%. This corresponds reductions of the time with negative discharges by 12% and 36%, respectively. This means substantial beneficial impacts with respect to saltwater intrusion.

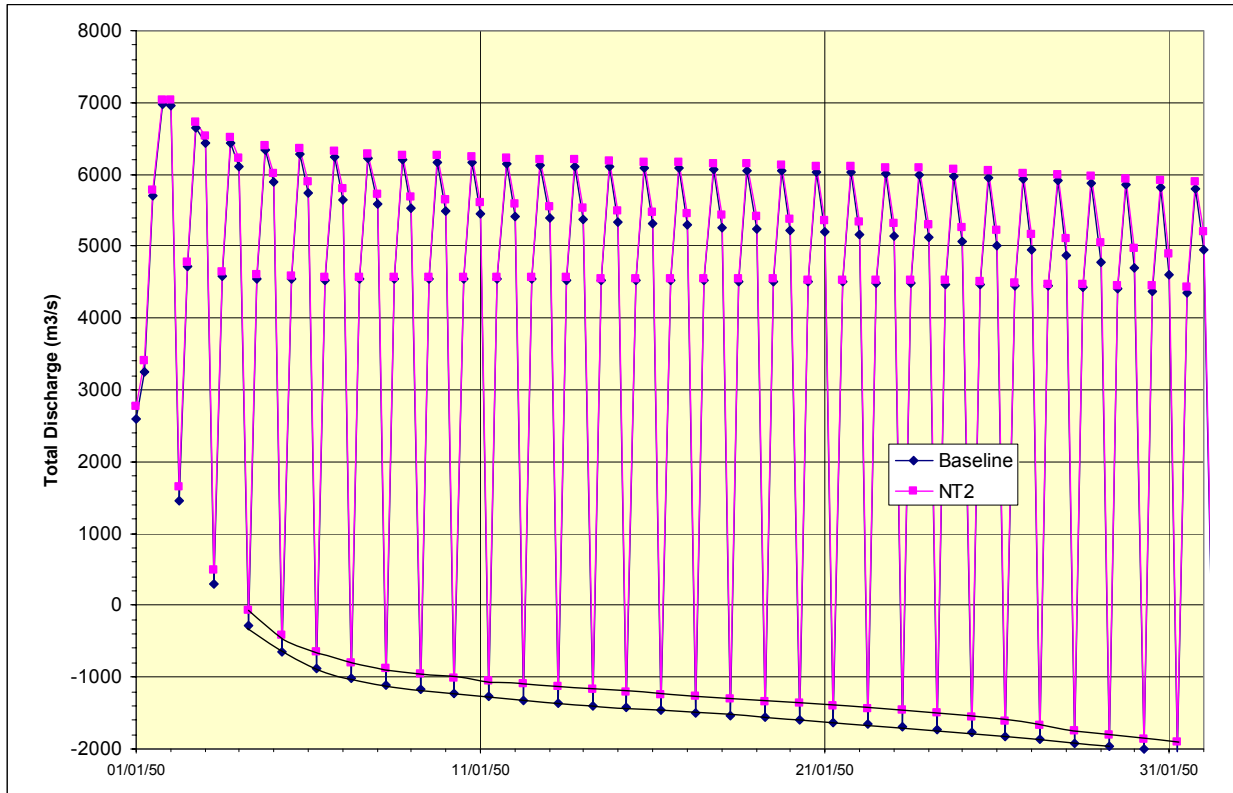


Figure 24 Simulated tidal oscillations of discharge in the Mekong Delta. Two lines outline the “envelope” of negative flows for the two scenarios: pre- and post-NT2.

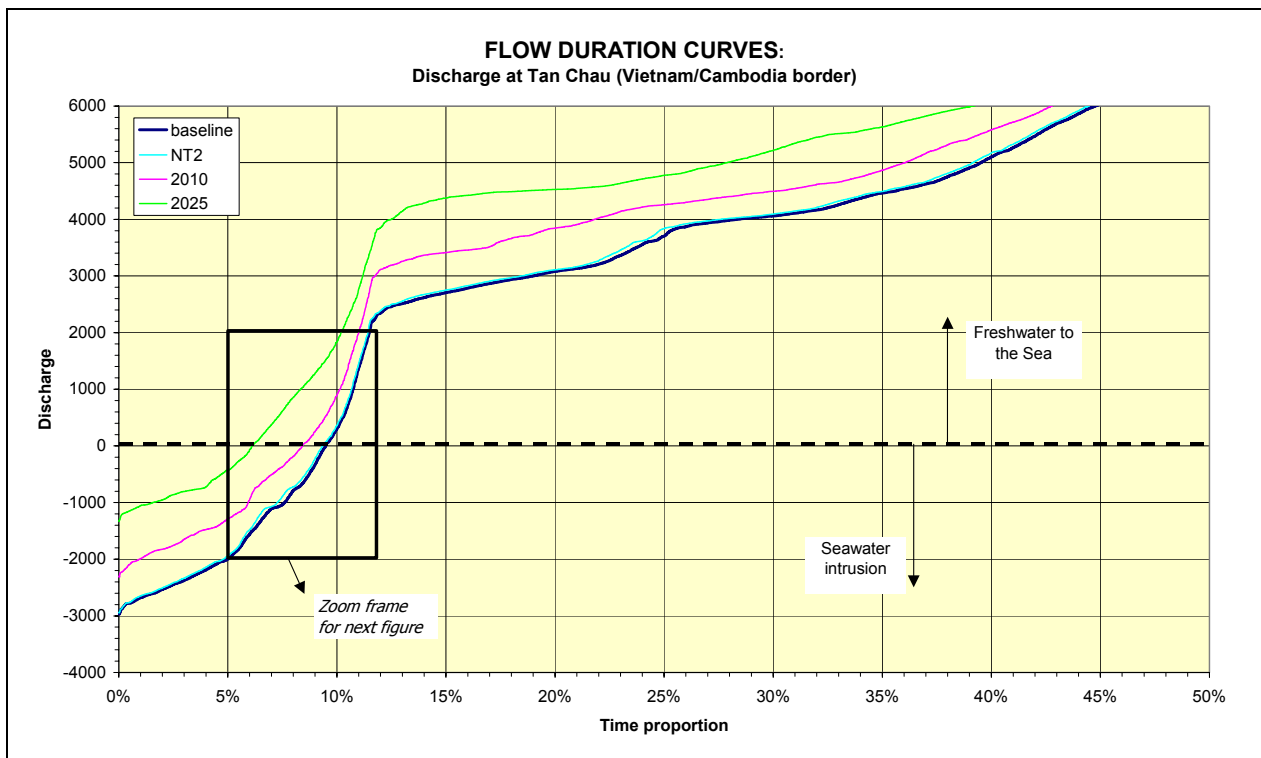


Figure 25 Flow Duration Curve (Discharge interval <6000 m3/s, i.e. dry season). Illustrates scenario impacts on flow duration: Duration of negative discharges is reduced due to regulation. The bold frame indicates the area that is zoomed to on Figure 26.

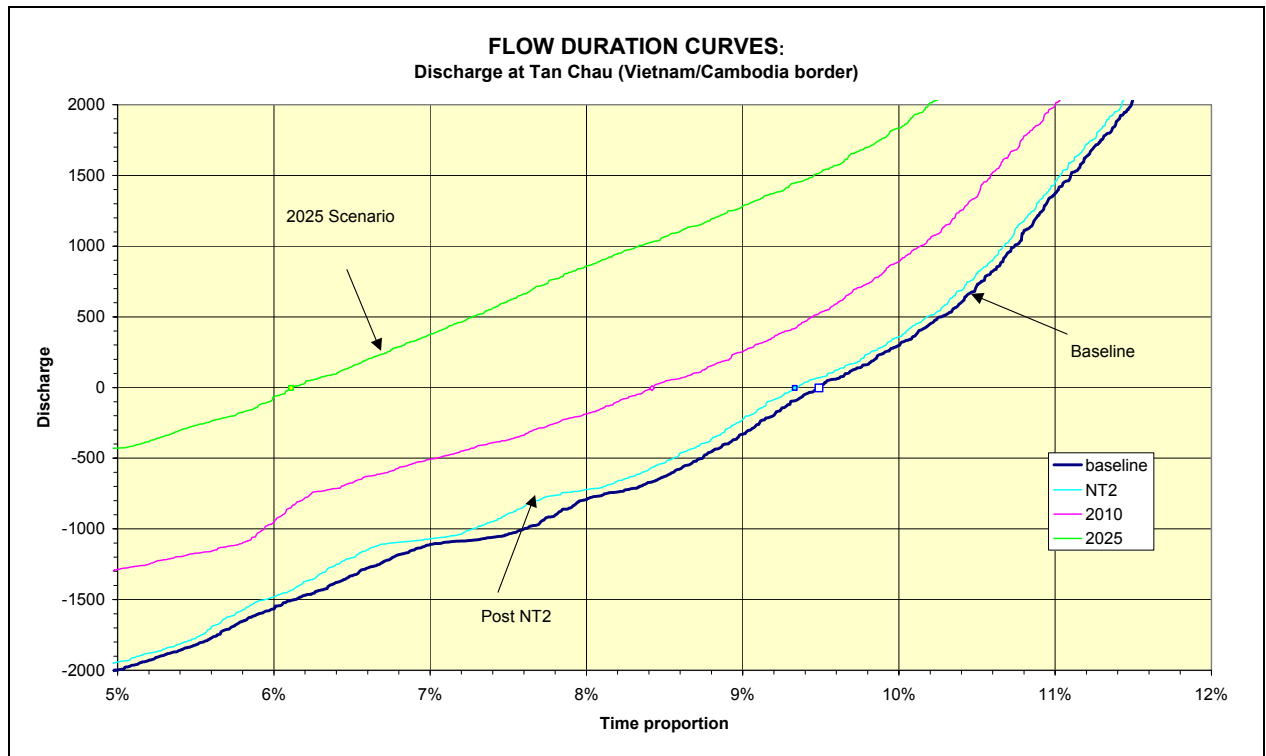


Figure 26 Flow Duration Curve (Discharge interval <2000 m³/s). Illustrates scenario impacts on flow duration: Duration of negative discharges is reduced due to regulation..

FIGURES AND TABLES

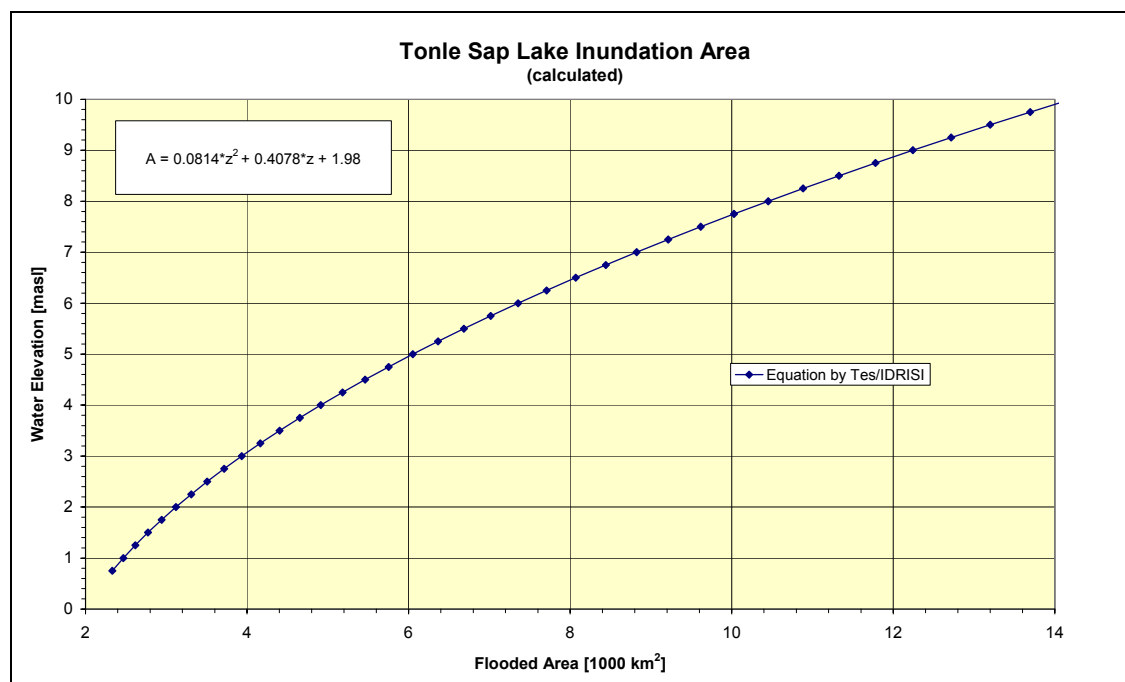


Figure 27 Storage Curve for Tonle Sap Lake. Established by Tes et al (1998).

Table 6 Monthly Mean Sea Water Levels at the Mekong Delta (unit: cm)

Station	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tan An (East Sea)	40	31	24	14	5	-7	-6	1	22	52	61	50

Note: Observation period is unknown.

Source: Flood Control Planning for the Inundation Area of the Mekong Delta in Vietnam, SIWRP, 1998

Table 7 Monthly Maximum Tidal Amplitude at the Mekong Delta in 1985 (Unit: cm)

Station	River	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Vung Tau	East Sea	351	359	322	341	341	373	368	348	320	346	371	374
Vam Kenh	Tieu	332	315	299	271	323	326	332	310	307	317	336	347
Binh Dai	Dai	305	301	278	286	305	305	298	293	284	297	313	315
Tan Thuy	Ham Luong	308	311	285	294	315	315	304	299	291	308	318	324
Ben Tray	Co Cien	329	332	294	310	335	340	334	331	312	330	343	353
Ganh Hao	Ganh Hao	342	356	322	360	358	350	338	338	334	356	366	368
Rach Gia	West Sea	109	109	110	111	111	123	119	121	94	82	104	110
Tan Chau	Mekong	65	85	95	110	98	96	27	26	9	6	16	33
Cho Moi	Mekong	110	124	130	145	140	139	80	78	35	17	45	72
My Thuan	Mekong	177	187	187	195	193	209	180	186	167	126	131	157
My Tho	Mekong	258	263	257	256	272	279	269	267	249	244	245	248
Chau Doc	Bassac	79	98	108	124	126	107	33	30	10	6	16	38
Long Xuyen	Bassac	134	147	144	154	155	163	112	109	66	40	62	94
Can Tho	Bassac	208	224	215	232	234	247	210	210	168	140	152	184
Dai Ngai	Bassac	303	321	300	312	322	324	299	292	269	274	281	294

Source: Water Level Analysis, Program of Salinity Intrusion Studies in The Mekong Delta Phase III, SIWRPM, 1992

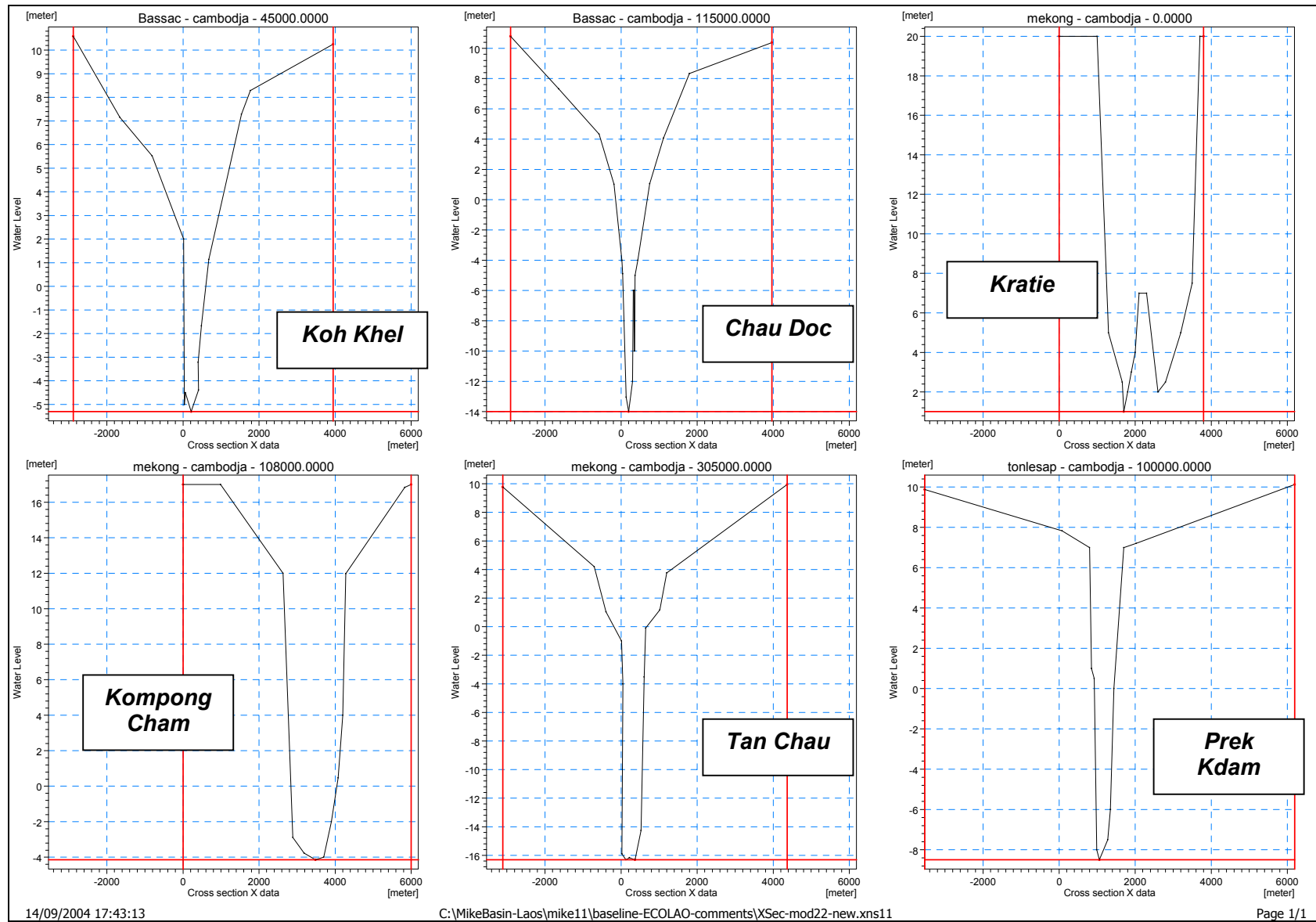


Figure 28 Selected Example Cross Section Profiles.

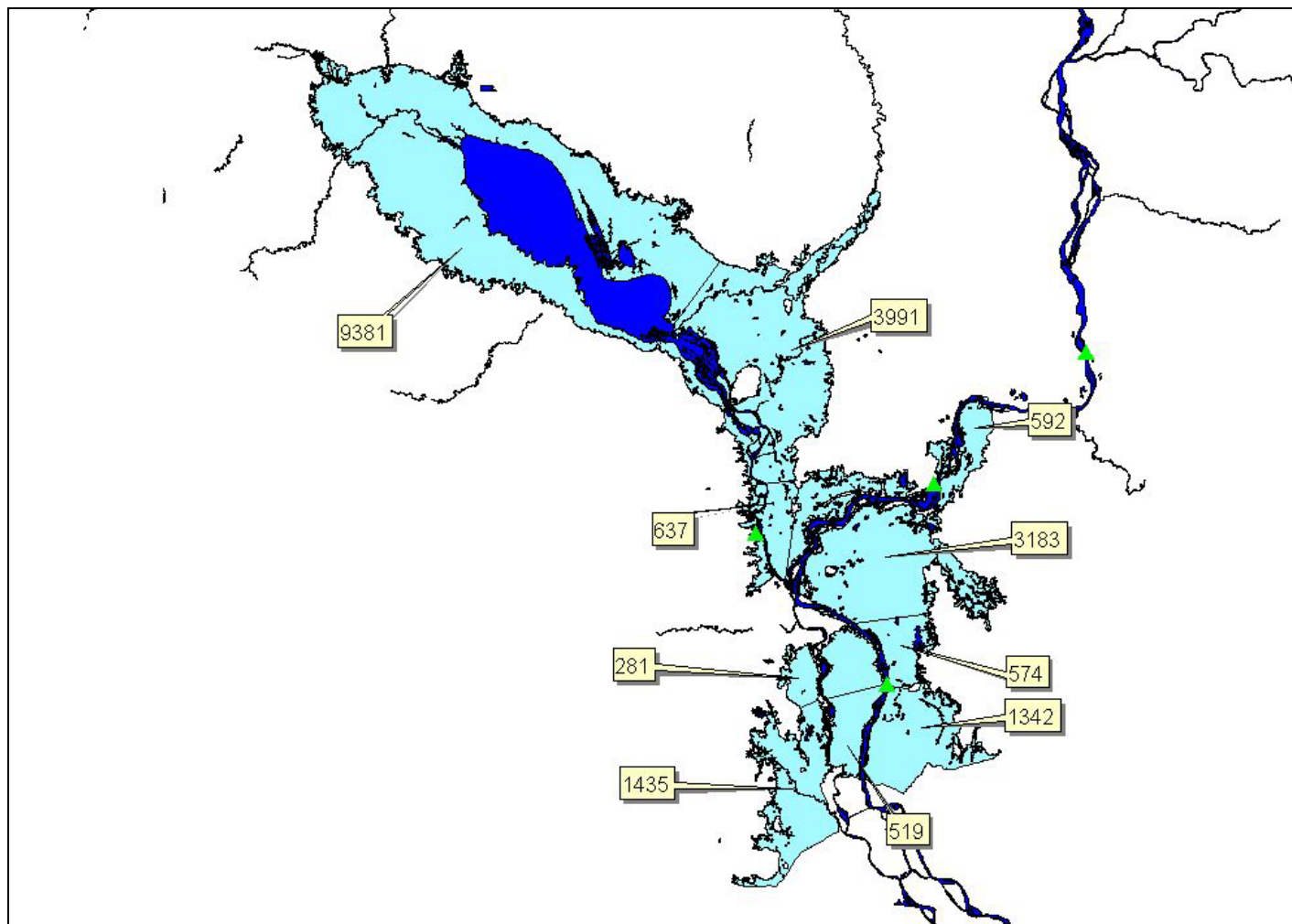


Figure 29 Inundated areas on 30th August 2001 (light blue). Figures are used as floodplain storage in Mike11. All figures in square km. Dark blue areas are permanently inundated.

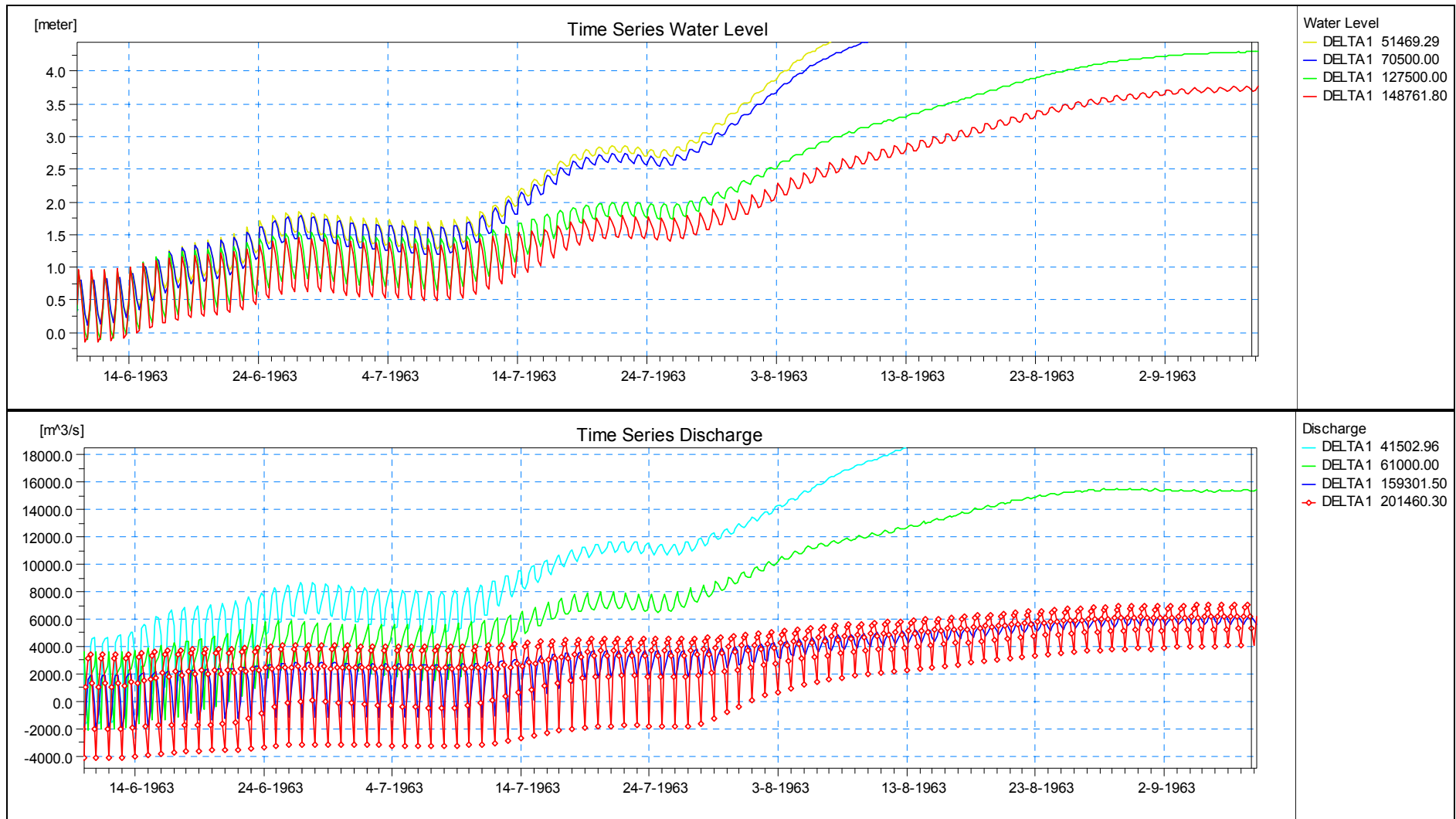


Figure 30 Tidal effects in the Delta. Simulated water levels and discharges. Note negative discharges (reverse flow) in the dry season, i.e. saltwater intrusion. Reporting points located 10 - 170 km from river mouth (mouth = 212,000).

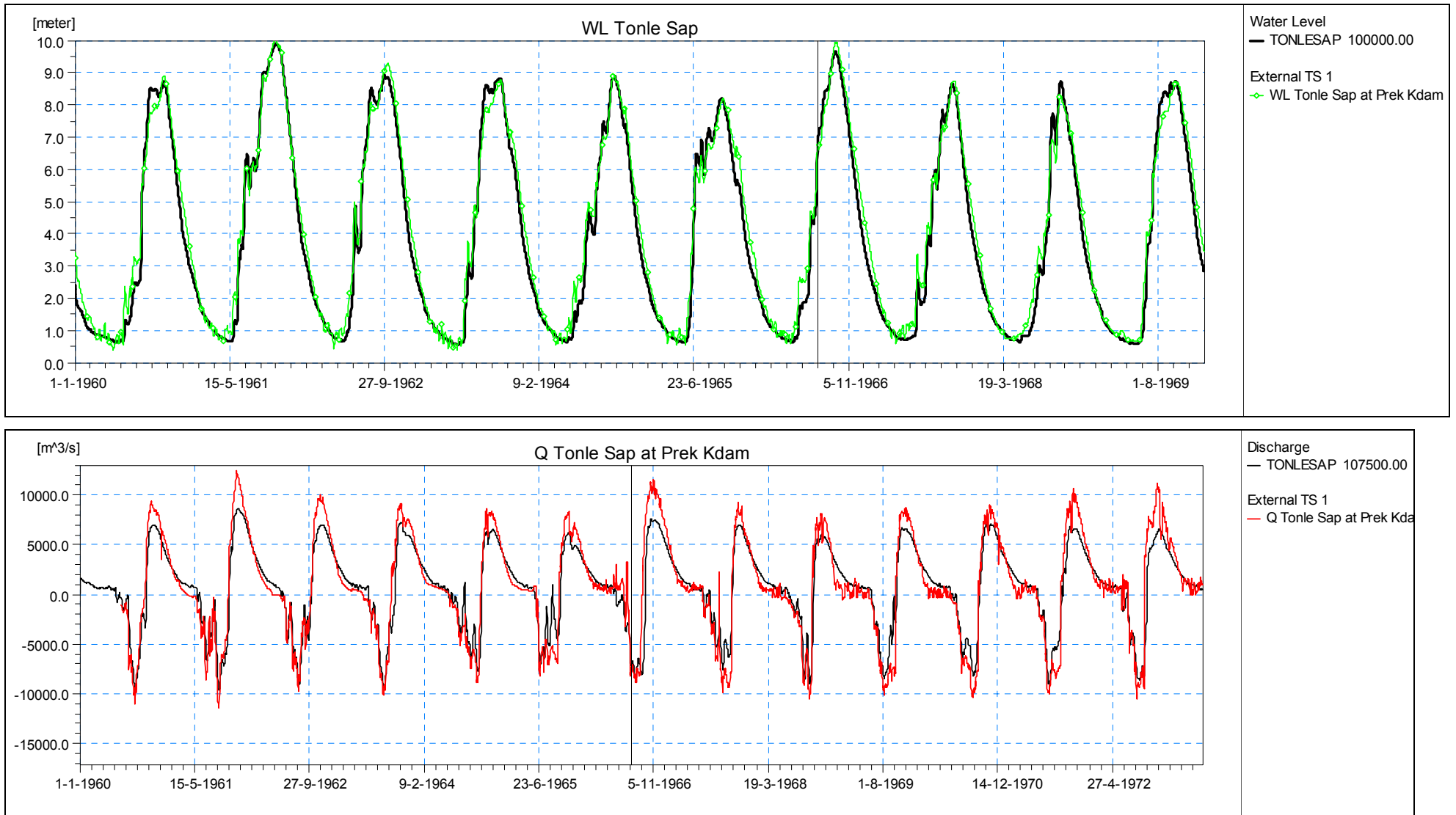


Figure 31 Calibration Result, Tonle Sap river at Prek Kdam: Comparison of observed and simulated water levels (above) and discharges (below).

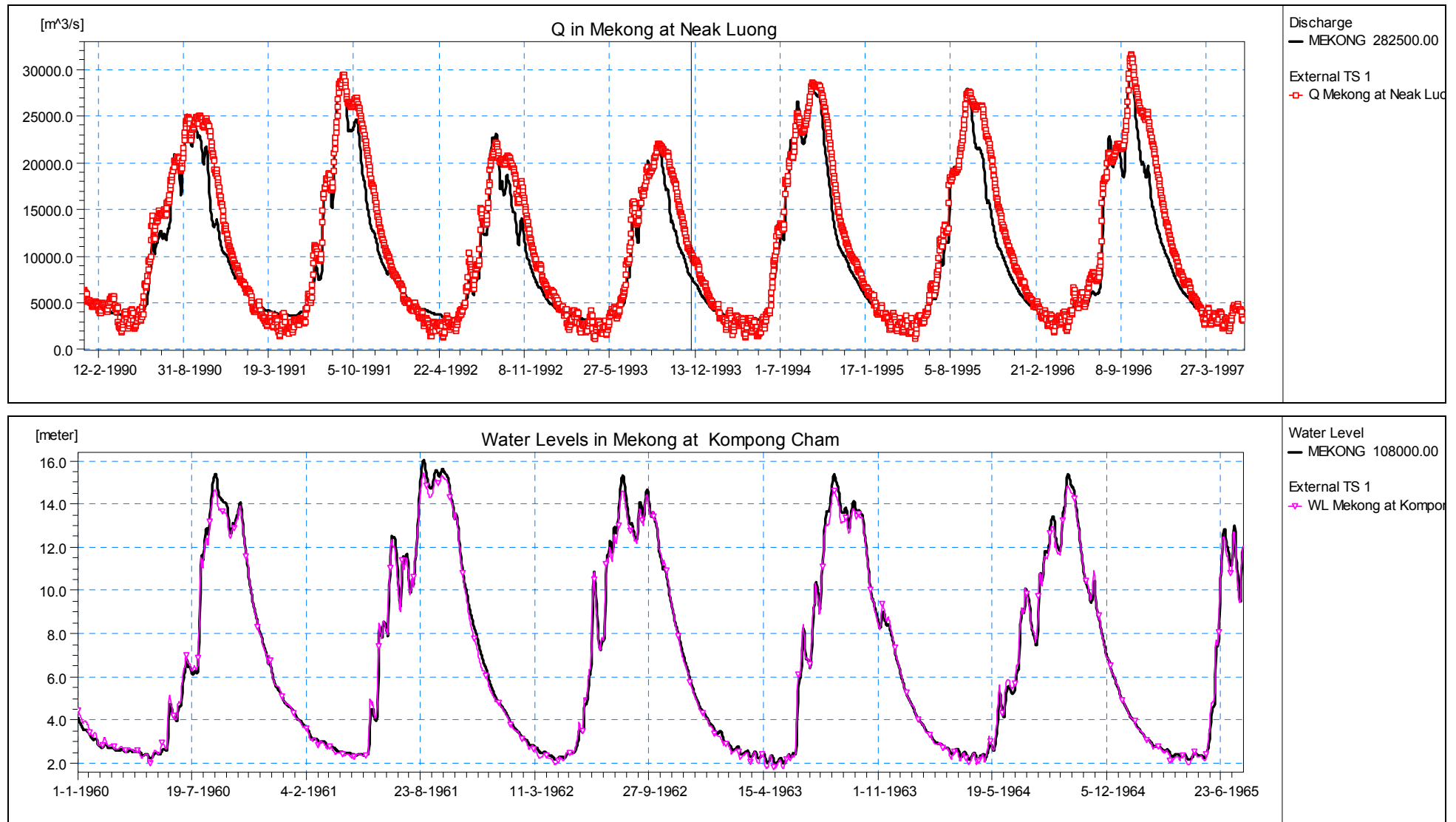


Figure 32 Calibration Result: Comparison of observed and simulated discharges at Neak Luong (above) and water levels at Kompong Cham (below).

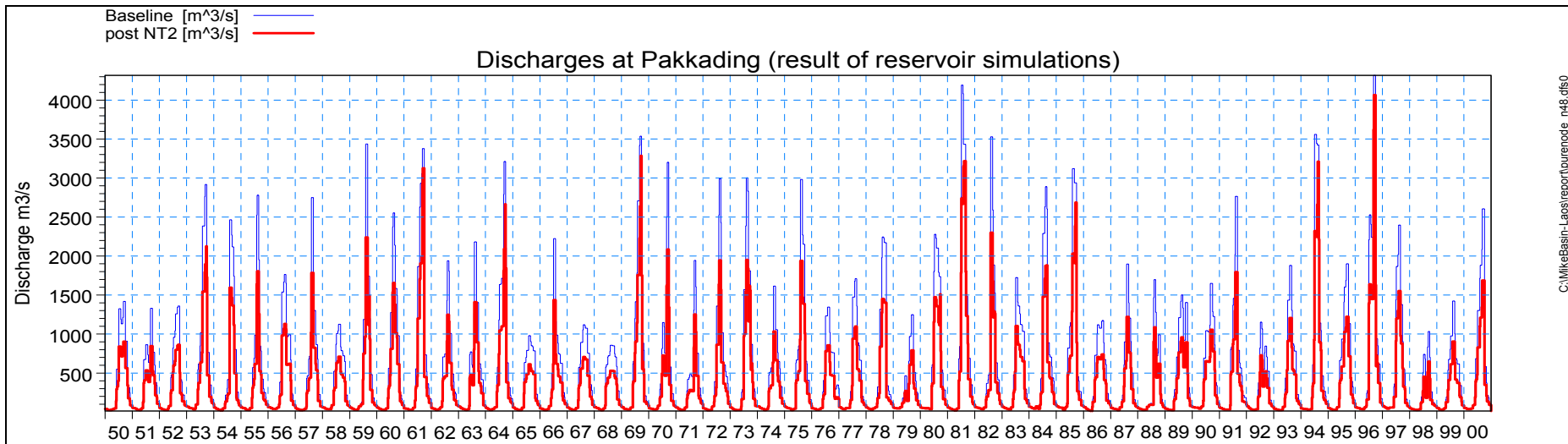


Figure 33 Result of reservoir simulations: Nam Kading discharges at Pakkading (Mekong Confluence). Baseline and post-NT2.

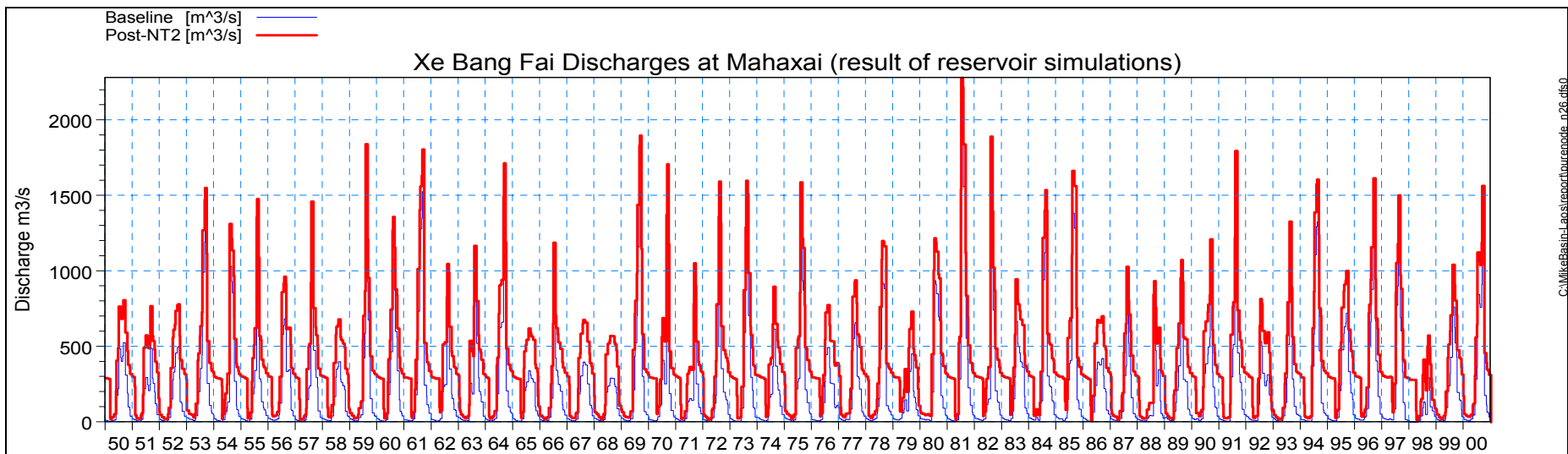


Figure 34 Result of reservoir simulations: Xe Bang Fai discharges at Mahaxai. Baseline and post-NT2

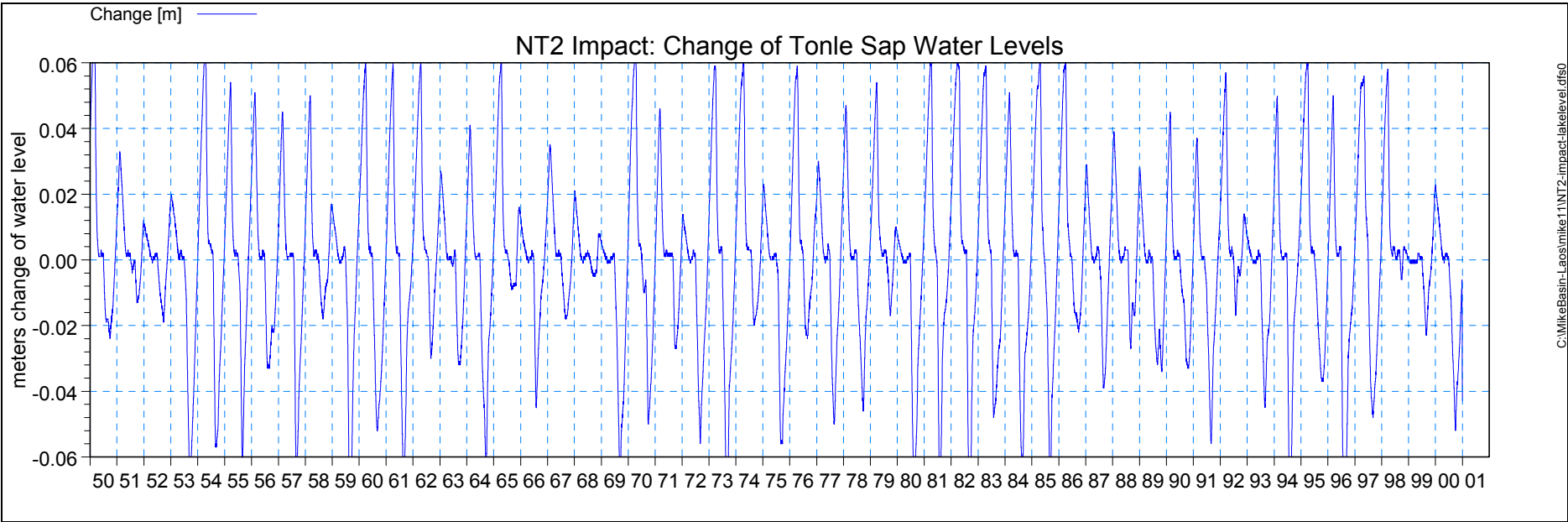


Figure 35 Simulated NT2 impact on Tonle Sap lake levels: Difference between daily lake levels pre- and post-NT2 ($\Delta H = H_{NT2}$ minus $H_{baseline}$). Negative figures means reduced level.

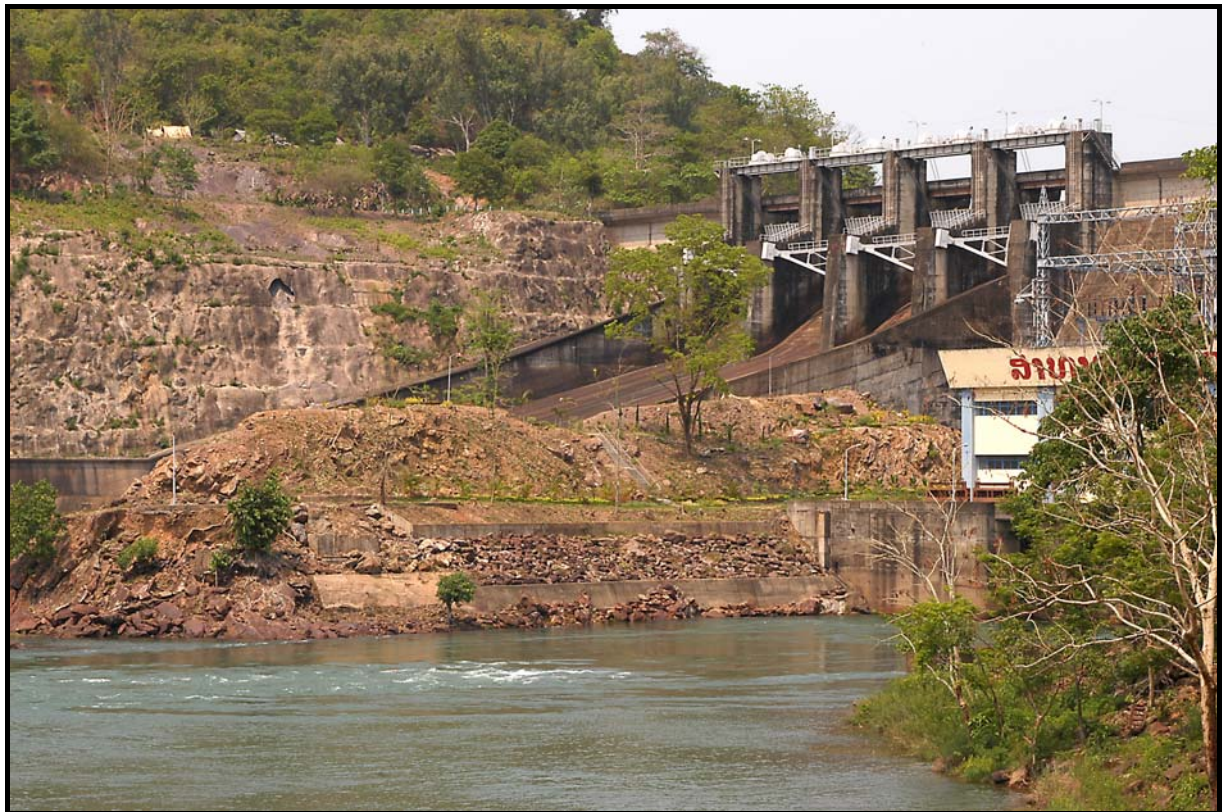
5 References

- Mekong River Commission' s homepage:
http://www.mrcmekong.org/info_resources/ffw/stationlist.htm
- Tes, S., 1998. *Hydrological studies of the Tonle Sap Great Lake area*. MRC/UNDP project for Natural Resources-based Development Strategy for the Tonle Sap area, Cambodia. Final Report, Vol. 2 Part B, Sectorial Studies. 53p.
- WUP-JICA Team, 2003: *Maintenance of Flows on the Mekong Mainstream*. Interim Report (Paper IV).
- Nguyen Dinh Tien (1992), *Analysis of Salinity Intrusion Length, Programme of Mekong Delta Salinity Intrusion Studies in the Mekong Delta Phase III*, Sub-Institute of Water Resources Planning and Management (SIWRPM).
- *Flood Control Planning for the Inundation Area of the Mekong Delta in Vietnam* (1998), SIWRPM, 1998.
- CTI Engineering International Co., Ltd., DHI Water and Environment: *Consolidation of Hydro-Meteorological Data and Multi-Functional Hydrologic Roles of Tonle Sap Lake and Vicinities*. 2003. Mekong River Commission.



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ANALYSIS AND NAM THEUN 2 CONTRIBUTIONS



Annex 3: Hydropower Development

Operation of reservoirs, assumptions and input data.

Prepared by: Anders Korvald

November 2004

TABLE OF CONTENTS

1	INTRODUCTION	1
2	ASSUMPTIONS	1
2.1	Model description.....	1
2.2	Technical assumptions.....	2
3	RESERVOIR AND HYDROPOWER DATA	5
3.1	Reservoirs in Lancang, Yunnan.....	5
3.2	Reservoirs in Lao PDR.....	8
3.3	Reservoirs in Thailand.....	9
3.4	Reservoirs in Vietnam.....	10
3.5	Reservoirs in Cambodia.....	11
3.6	Summary of reservoirs in Mekong.....	11
4	FLOODING	12

LIST OF FIGURES

<i>Figure 3-1. Location of large existing and planned reservoirs for hydropower and irrigation.</i>	6
<i>Figure 3-2. Monthly river flow at border to Lao PDR before (natural) and after construction (in percentiles) of planned hydropower projects in Yunnan.</i>	7
<i>Figure 4-1. Daily discharges for Mekong just upstream Tonle Sap and the discharge in Nam Theun, during a high flood in Nam Theun.</i>	13

LIST OF TABLES

<i>Table 3-1 Hydropower projects in Lancang, Yunnan (projects in bold are included in the 2010-scenario).</i>	5
<i>Table 3-2. Storage hydropower projects in Nam Ngum, Lao PDR (projects in bold are included in the 2010-scenario).</i>	8
<i>Table 3-3 Storage hydropower projects in Nam Theun, Lao PDR (projects in bold are included in the 2010-scenario).</i>	9
<i>Table 3-4 Storage hydropower projects in Se Kong, Lao PDR (projects in bold are included in the 2010-scenario).</i>	9
<i>Table 3-5. Existing reservoirs in Thailand.</i>	10
<i>Table 3-6 Storage Hydropower projects in Se San and Sre Pok, Vietnam (projects in bold are included in the 2010-scenario). PS! The sum includes the other smaller projects (active storage less than 100 mill.m³).</i>	10
<i>Table 3-7 Storage Hydropower projects in Se San and Sre Pok, Cambodia. (no projects are included in the 2010-scenario).</i>	11
<i>Table 3-8. Active storage in the Mekong basin.</i>	11

1 INTRODUCTION

One main task of the Cumulative Impact Analysis (CIA) has been to estimate the cumulative impact on hydrology. All reservoirs have an impact on the hydrological balance their purpose being flood control, water supply, irrigation or hydropower generation. This section presents the hydrological changes caused by future large projects, mainly hydropower, within Mekong catchment, whereas the resulting flow and water levels in Mekong are presented in the main report and the methodology in Annex 2.

The future variation in water flow in Mekong depends on the future number and size of active storage of seasonal reservoirs. The cumulative impact of Nam Theun 2 depends on other reservoir development and the regulation of the other reservoirs.

The largest potential projects are mainly located in Lancang, and in the Nam Ngum, Nam Theun, Se Kong and Se San basins.

In the CIA one scenario is the situation in 2010 and the other in 2025. The selection of projects within scenario 2010 is based on projects under construction or close to financial closure. For the 2025 lists from MRC and National Power Development Plans has been used.

Because of limited time available, the work on the hydrological impact of future reservoirs have been simplified. Small HPP and Run-of-river projects are not included. For multipurpose projects the irrigation demand will have an impact on the reservoir operation and thereby the potential energy production and downstream water balance. An optimisation of the total output from the basin, both energy production and irrigation utilisation, has not been carried out.

Optimal reservoir operations are particularly difficult to forecast for multipurpose projects and model assumptions must be made regarding abstraction for hydropower, the volume of storage dedicated to flood protection and/or irrigation.

2 ASSUMPTIONS

2.1 Model description

The calculation is based on the simplification of having an equal tariff throughout the year. A simulation of and reservoir operation by maximising the profit should have been carried out, but since the future market situation in the different countries is unknown, the criteria of maximising the energy production has been used instead. Another simplification is the disregard of storage allocated for flood control. It is expressed in certain references that the regulation of the reservoirs will take into account flood storage. To what extent this is planned is not known and the practical operation of this obligations are even more uncertain.

Another simplification is ignoring the impact of existing power plants on the historical record used for Mekong (1950-2000). In this period some large reservoirs have been established in Lao PDR (Nam Ngum) and Thailand. Inflow and outflow records from these projects should preferably have been used to generate a "natural" flow series in Mekong. Due to lack of data and since only the second half of the 1950-2000 –record is influenced, the impact has been ignored. A

simulation could have been carried out to generate the impact, but actual filling procedures, minimum discharges, irrigation demand (Thailand), operation pattern etc. are not known. Development stages (e.g. Nam Ngum: 1972: 30 MW, 1979: 110 MW and 1985: 150 MW) make it even more difficult.

Two different scenarios are considered, one presenting the status in 2010 and one presenting the status in 2025. The existing stations (with storage) are included in both scenarios.

The operation of the reservoirs may be represented by either a rule curve or by a system approach where water values are used. Because the future transmission system and value of energy (or irrigation or flood control) is unpredictable, a rule curve approach is sufficient at this stage. By using rule curves the reservoir operation tend to be similar for all years. In a larger system a higher flexibility in the reservoir operation is necessary, which is best achieved by using a system approach.

In the present model there is only one rule curve: if the reservoir level is below this curve the power plant will produce less and when the reservoir level is above the curve the plant output is increased. The determination of the rule curve is carried out by iteration trying to find the highest income or energy production of the power plant(s). If there are several reservoirs or hydropower plants in the basin the total energy production in the basin is maximised according to the same rule curve.

Operation of the reservoir in the model is not strictly following the rule curve. If there is a high inflow and the turbines are running at full capacity and the water level in the reservoir is above the rule curve, the excess water will be stored. Spilling will not take place until full supply level is reached.

The reservoir operation has not been optimised by trying to find the potential highest firm power and/or firm energy. A firm power demand will determine whether the inflow is used for storage or power production. A high firm power demand will result in high reservoir levels in order to secure the power obligations, but the risk of spillage will also be high and hence the total power production may drop. Firm power and firm energy is used to characterise the quality of the supplied power and energy. In a system dominated by thermal power, the main problem in planning further development is to ensure that total plant capacity is sufficient to cover the maximum peak load that will occur. The term firm power is used to characterise this capacity.

There are many uncertainties in the simulations. Although there is a gap in the energy balance at present, the grid or market might be a limitation in the future production since the future regional demand and location of transmission lines are unknown. To meet this situation or to meet financial requirements, a project might be developed in stages (as Nam Ngum) and thereby the reservoir is not utilised.

2.2 Technical assumptions

The technical and energy production data referred to in Chapter 3 are taken from [4]. The following general assumptions have been made:

- *Inflow records* has been generated by using some few gauge records of long measurements period; Chiang Saen, Nam Ngum, Ban Signo and Se

Kong- Se San. These records have been scaled by the average inflow for each project.

- *Reservoir capacity curves* provide the relationship between elevation, storage and surface area. This data is required to calculate power production, to determine reservoir operation and evaporation. Where these data have not been available, simplified reservoir curves have been estimated based on active storage, total storage capacities and dam heights.
- Optimisation of reservoirs by finding the *rule curves* giving the highest energy production. Usually the operation is optimised by finding the highest income, but the future tariff structure is uncertain, the market is uncertain (domestic/export) and the project features might change due to upstream development. Determining the real daily reservoir operation would have to be based on expected energy prices, expected inflow and environmental requirements.
- Large reservoirs will have water loss due to *evaporation*. However, it can be argued that difference between the present evaporation and evapotranspiration pre-construction, is small and neglectable. Evaporation from reservoirs is usually included in reservoir simulations. For the projects in the actual area the evaporation could have been included by 500-1300 mm/year. In e.g. in Yunnan the impact on total flow would be less than 0.1 %. The reason is the topography of the reservoir area consisting of steep hillsides implying small reservoir areas in relation to total storage (large regulation zone). In any case the following assumptions have been made: If the pre-inundated area originally consisted of ever-green forest or slash and burn areas, the evaporation would have been almost equal to the evaporation after the construction of the dam. In addition the reservoir surface shrinks in the dry season and bare sand banks are exposed giving almost no evaporation.

In many projects detailed data have not been available and the following technical assumptions have been made to carry out the energy calculation:

- *Losses in waterways*: At full capacity the total head losses in the waterways are calculated based on rated head, maximum discharge and rated capacity.
- At full capacity a total *efficiency factor* of 0.88-0.90 has been used, containing an efficiency of 0.88-0.93 for the turbines (old-new and Pelton-Francis), 0.97 for the generators and 0.99-0.995 for the transformers. Because every project of interest has a reservoir the turbines are operated at optimum discharge or at maximum discharge. The power plant discharge depend on the head as follow: $Q = Q_{\max} (h/h_{\text{rated}})^{0.5}$
- The energy losses in waterways and efficiency of turbine, generator and transformer depend on the *operation mode*. Running the turbines at full capacity during peak hours and partly in the off-peak period gives a higher loss than running the power plant at same load throughout the day. In the simulation no peak power operation is assumed, i.e. same load throughout the day.
- A *minimum flow* is only included in the Nam Theun projects (only data available).

- *Gravity constant* (g) of 9.81 m/sec^2 is used (actually dependent on latitude and elevation).
- The total of *forced and planned outages* are assumed to be 1% in general. The outages are caused by:
 - Maintenance of electrical and mechanical equipment.
 - Maintenance of tunnels and shafts. Cleaning of sand-trap, inspections of tunnels, painting of steel lined shaft and penstocks.
 - Flood or high sediment concentrations, intake area flushing.
 - Unpredictable outages: E.g. strikes, transmission line break-down, earthquakes, landslides giving very high sediment load in the water, etc.
- The *transmission line losses* between the power plant switchyard and the load centre are not included. A 8-10% loss may be used for rough estimates for transmission and distribution, but shorter lines, refurbishment and new transmission lines will change this figure. The reference point for the energy production calculation is therefore the power station switchyard.

The energy production has been calculated based on the following equation:

$$(100\% - \text{outages}) \times \text{Efficiency} \times g \times \text{Power plant discharge} \times \text{Net head} \times 24 \text{ hours} \times \text{No. of days per month} \quad [\text{kWh/month}]$$

The data on simulated energy differs from the project specific data because upstream development is not foreseen in the specific projects studies.

3 RESERVOIR AND HYDROPOWER DATA

3.1 Reservoirs in Lancang, Yunnan

Based on data from “Sustainable development of Lancang–Mekong” by He Damming [1], the energy production and resulting outflow of 8 of the largest hydropower plants in Lancang (Upper Mekong), Yunnan, have been simulated. The location of the projects are presented in a map in *Figure 3-1*. Because the average flow is known but not the flow variation, the inflow has been estimated by using the monthly inflow data from the gauge station just downstream at Chiang Saen and Luang Prabang in the period 1951-2001 and 1966-2002, respectively. The total energy production based on He Damming is 74 060 GWh/year, whereas the calculated energy production based on the record from Chiang Saen and Luang Prabang is 76 284 and 75 611 GWh/year, respectively. The calculation is based on the data presented in *Table 3-1*.

Table 3-1 Hydropower projects in Lancang, Yunnan (projects in bold are included in the 2010-scenario).

Reference No. In Map		1	2	3	4	5	6	7	8	
Power plant		Manwan	Dachaosh Xiaowan	Gonguoqia Xiaowan	Gonguoqia Jinghong	Nuozhadu	Mengsong	Ganlanba		SUM
Completed	year	1993-1996	2001-2003	2010-2012	2011	2013	2014	before 2025		
Average inflow	m ³ /sec	1230	1340	1220	985	1840	1750	2020	1880	
Total storage	Mm ³	920	933	14560	510	1233	22400	0.9	0.2	40 557
Active storage	Mm ³	257	367	9900	120	249	12300			23 193
Full Supply Level	m a.s.l.	994	906	1236	1319	602	807	519	533	
Min. Operation Level	m a.s.l.	982	860	1162	1311	595	756	518	532	
Surface at FSL	km ²	4.2	8.3	37.1	3.4	5.1	45.1	0.9	0.18	104
Net Head ¹⁾	m	89	80	248	77	67	205	28	10	804
Dam height	m	126	110	300	130	118	254			
Plant capacity ¹⁾	MW	1500	1350	4200	750	1500	5500	600	150	15 550
No. of turbines		6	6	6	3	5	10	4	4	44
Energy	GWh	7870	7090	18540	4670	8470	22670	3740	1010	74 060
Sim. energy ²⁾ , Chiang Saen	GWh	8209	6898	19121	4062	8528	24304	4085	1077	76 284
Sim. energy ³⁾ , Luang Prabang	GWh	8115	6787	18987	3936	8488	24200	4031	1066	75 611
Resettlement	persons	3513	6054	32737	4596	2264	23826	258	71	73 319
Reservoir-%		0.7 %	0.9 %	25.7 %	0.4 %	0.4 %	22.3 %	0.0 %	0.0 %	
Reservoir-% ref. Mengsong		0.4 %	0.6 %	15.5 %	0.2 %	0.4 %	19.3 %	0.0 %	0.0 %	36.4 %

1) Efficiency curve is estimated based on expected normal values. Based on Net head and general layout the head losses and tailwater level is generated thereafter.

2) Inflow record is based on monthly flow at Chiang Saen, 1951-2001. All u/s hydropower are developed.

3) Inflow record is based on monthly flow at Luang Prabang gauge station, 1966-2002. All u/s hydropower are developed.

Ref. Water Resources and Hydropower - Policies and Strategies for the Sustainable Development of the Lancang River Basin, by Prof He Daming and Dr David Plinston, Sep-99.

Since two of the projects already exist (Manwan and Dachaoshan) and construction of third project has started, three projects are included in the “2010”-scenario whereas the other five projects are scheduled between 2010 and 2025.

The present impact of existing regulations in Yunnan is small. The storage of the existing projects is only 1% of the total annual inflow (ref. Mengsong), but the construction of Xiaowan HPP would increase the regulation to 17% in 2010-12. Two of the future projects, the Nuozhadu HPP and Xiaowan HPP, would be able to store (active) almost 35 % of the total inflow (ref. Mengsong).

Figure 3-1. Location of large existing and planned reservoirs for hydropower and irrigation.

Dr Adamson has analysed the impact of hydropower development in Yunnan on the Lower Mekong [3]. He refer to the impact of 10% and 20% regulation. However, the “2010”-scenario would provide a regulation of 17%, whereas the “2025”-scenario would imply a regulation of 36 %. In addition, the paper do only present the monthly mean flow and do not present the variation in monthly flows.

Figure 3-2 shows the water flow downstream Mengsong before (Natural Inflow – mean average) and after the scheduled hydropower development in the year 2025 (50% percentile – approx. mean average)

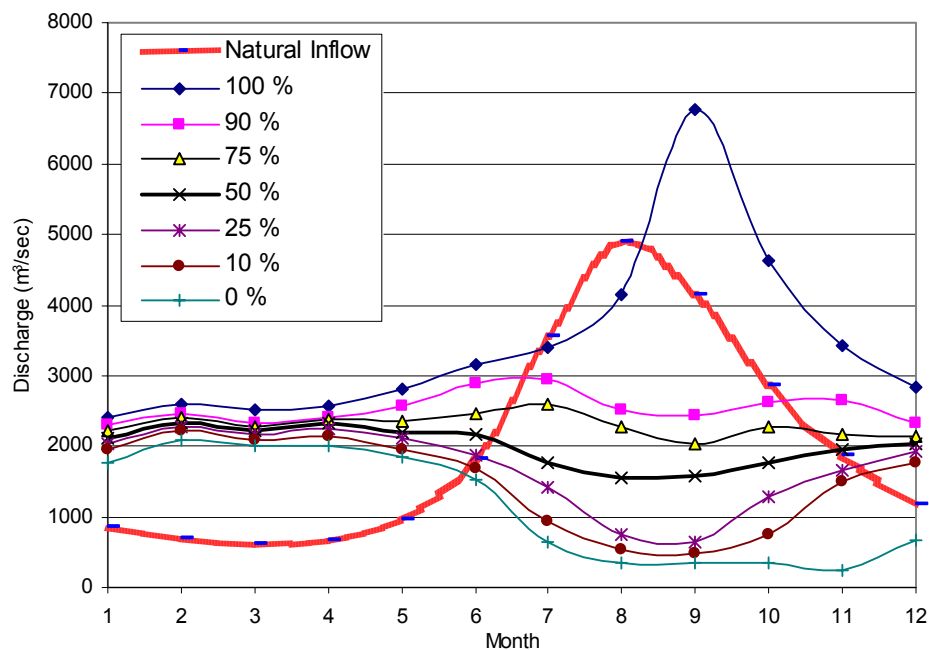


Figure 3-2. Monthly river flow at border to Lao PDR before (natural) and after construction (in percentiles) of planned hydropower projects in Yunnan.

In the 2025-scenario there will be insignificant difference between dry season and wet season flow. In fact, in some years the low flow may occur in July to October if the value of energy is higher during winter.

The trend in the 2010-scenario will be the same, although the period with highest flow in Lancang will still be during the normal “wet season”.

Irrigation

According to [2] the agriculture cultivation in Yunnan is mainly carried out in small valley areas along the middle and lower stretch of Lancang. The total of the major irrigation area is about 151 000 ha (1500 km²) in the lower mainstream. Based on [1] there is 550 000 ha farmland in Yunnan within the Lancang basin among which paddy field account for 39%. From the reservoir at Manwan HPP the amount of water has capacity for irrigating 161 300 ha. By assuming an average consumption of 1.5-2 l/s per ha, the total consumption may be estimated. However, much water is returning either as surface run-off/drainage or fed to the groundwater. By assuming an annual evaporation of 1000 mm/year from paddy fields the water loss is 0.3 l/s per ha. However, there was evapotranspiration from

the area before the paddies were established. This might have been the same rate (depending on type of original vegetation cover).

Assuming dry season irrigation of paddy the water loss in existing paddies would represent $0.39 \times 550.000 \times 0.3 / 1000 \text{ m}^3/\text{sec} = 64 \text{ m}^3/\text{sec}$.

Planned irrigation of 161300 ha by diverting water from Manwan would in the same way imply a water loss of about $48 \text{ m}^3/\text{sec}$. This number is, however, not included in the simulation because the natural/original evapotranspiration is unknown.

3.2 Reservoirs in Lao PDR

In Lao PDR there are a large number potential hydropower sites on Mekong tributaries. Based on EdL power development plan 20 projects have been selected [4]. The location of the projects are presented in Figure 3.1. Because the average flow is known but not the variation in inflow the variation has been estimated by using the monthly inflow data from the "Inflow Nam Ngum"-record and the flow at Ban Signo gauge station (Nam Theun 2). The Nam Ngum record has been extrapolated to be used in the period 1951-2001. In Se Kong a hydrological record has been generated by using the monthly inflow data from the Ban Signo gauge station and correlating this record with the monthly distribution in Se Kong given in [6].

Based on trend analysis, see Annex 2, all inflow records in Lao PDR have been reduced by 8%. In spite of this, the simulated basin-wise sum of energy becomes slightly higher than the energy production figures given in the project documents. (Nam Ngum and Nam Theun). The main reason is probably that reservoirs have secondary benefits for all downstream projects.

The calculations of hydrological inflow to Mekong is based on the data in Table 3-2, Table 3-3 and Table 3-4 referring to Nam Ngum basin, Nam Theun basin and Se Kong basin, respectively.

Table 3-2. Storage hydropower projects in Nam Ngum, Lao PDR (projects in bold are included in the 2010-scenario).

Reference No. In Map		10	11	12	13	14	15	17	18	20	
Power plant		N Ngum	N Leuk	N Song	N Lik	N Ngum 3f	N Ngum 2f	N Ngum 5	N Ngum 4f	N Bak 2B	SUM
Completed	year	1972-78	2000	2000	2007						
Average inflow	m ³ /sec	305.9	11.2	65.5	89	106	189	23	27	15	
Total storage	Mm ³	7010	154		1095	1320			443	186	10 208
Active storage	Mm ³	4714	123		826	983	150	252	337	119	7 664
Full Supply Level	m a.s.l.	212	405		300	720	280	1100	1040	1030	
Min. Operation Level	m a.s.l.	196	388		270	660			1010	1000	
Surface at FSL	km ²	370	12.8		42.2	25.6	7.5	14.6	14.5	4.8	502
Net Head ¹⁾	m	45.5	183.0		80.8	322	65.8	292.5	158.0	624.0	
Dam height	m	55	45.5		63	217	90	97	65	77	
Plant capacity	MW	150	60		100	580	183	90	55	116	1 432
No. of turbines		5	2		2	6			2	3	
Energy	GWh	1018	230		390	2654	830	430	250	563	6 816
Sim. energy ²⁾	GWh	1013	143		417	2360	725	439	264	569	6 945
Resettlement	persons				2264	>500	1000	300-500	1470	1552	6 286
Reservoir-%		48.9 %	34.8 %		29 %	29.4 %	2.5 %	34.7 %	39.6 %	25.2 %	79.4 %

Ref. Power Sector Strategy Study, by Electrowatt-Ekono and PA Consulting Group, Sep.-02.

Ref. Nam Ngum 1 Hydropower Station Extension, by Lahmeyer and Worley, Aug. -95.

1) Efficiency curve is estimated based on expected normal values. Based on Net head and general layout the head losses and tailwater level is generated thereafter.

2) Given inflow. Inflow record is based on monthly flow at Nam Ngum 1, 1951-2001, correlated by Ban Signo and later reduced by 8%.

3) EdL is referring the alternative Nam Ngum 3B (690 MW). In the reference list data [5] NN3 and NN3E is available, but the active storage is the same. NN3E (588 MW) is used.

Table 3-3 Storage hydropower projects in Nam Theun, Lao PDR (projects in bold are included in the 2010-scenario).

Reference No. In Map		21	23	
Power plant		N Theun 2	TH. Ext	SUM
Completed	year	2009	2009	
Average inflow ²⁾	m ³ /sec	240	110	
Total storage	Mm ³	3910	4870	9 895
Active storage	Mm ³	3530	2870	6 460
Full Supply Level	m a.s.l.	538	540	
Min. Operation Level	m a.s.l.	525.5	510	
Surface at FSL	km ²	450	126	592
Net Head ¹⁾	m	341		
Dam height	m	48	119	
Plant capacity	MW	1074	105	1 424
No. of turbines		6	1	
Energy	GWh	5936	908	8 338
Sim. energy ²⁾	GWh	5490	1283	8 664
Resettlement	persons	4800	1220	6 020
Reservoir-%		47 %	83 %	

Ref. Power Sector Strategy Study, by Electrowatt-Ekono and PA Consulting Group, Sep.-02.

Ref. NT2. Environmental Assessment & Management Plan, October 2003.

1) Efficiency curve is estimated based on expected normal values etc.

2) Given inflow. The inflow record is based on monthly flow at Ban Signo, 1951-200,1and later re

Table 3-4 Storage hydropower projects in Se Kong, Lao PDR (projects in bold are included in the 2010-scenario).

Reference No. In Map		24	25	26	27	28	29	31	
Power plant		Huoay Ho Xepon		X Kaman 3	X Kaman 1	X Kong 5	N Kong 3	Xe Xou	SUM
Completed	year	1999	2008						
Average inflow	m ³ /sec	10.4	17	35	161	86	34	77	
Total storage	Mm ³	596	405		6112	4750	320	2750	14 337
Active storage	Mm ³	480	361	108	3340	2210	299	1710	8 579
Full Supply Level	m a.s.l.	883	580	960	280	500	540	180	
Min. Operation Level	m a.s.l.	861	560		250	470	520		
Surface at FSL	km ²	38	29.5	5.2	222.0	27.5	37.0	112.9	440
Net Head ¹⁾	m	763	272.5	568.0	170.1	195.2	77.5	58.0	
Dam height	m	77	36	99	184	205	62	62	
Plant capacity	MW	150	74	250	468	248	25	59	1 162
No. of turbines		2	4	3	4	3	1		
Energy	GWh	556	301	1349	1925	1183	142	277	5 274
Sim. energy ²⁾	GWh	531	311	1306	1575	1107	130	269	4 699
Resettlement	persons		1500		>800	5870	1550	500	9 420
Reservoir-%			67 %	10 %	66 %	81 %	28 %	70 %	

Ref. Power Sector Strategy Study, by Electrowatt-Ekono and PA Consulting Group, Sep.-02. X Kaman 3: Vietnamese study in 2004

1) Efficiency curve is estimated based on expected normal values. Based on Net head and general layout the head losses and tailwater level is generated thereafter.

2) Given inflow. Inflow record is based on monthly flow at Se Kong outlet and later reduced by 8%.

3.3 Reservoirs in Thailand

Nine projects with reservoirs of significant storage exist in Thailand, see *Table 3-5*.

Six of these projects are combined multipurpose projects, used for irrigation, hydropower and water supply. No plans exist for new large reservoirs projects) for the next 20 years. Hence, the present situation is expected to be the same as in 2010 and 2025.

Table 3-5. Existing reservoirs in Thailand.

Reference No. In Map		47	48	49	50	51	52	53	54	55	56	SUM
Power plant		Nam Pung	Ubol Ratana	Sirinhorn	Huai Kum	Chulabhor	Lam Phra	Nam Pao	Huai Luang	Nam Oon	Lam Takhon	
Completed	year	1965	1966	1971	1980	1972	1967	1971	1984	1973	2002	
Average inflow	m ³ /sec					188					320 / 10	
Total storage	Mm ³	150	2010	1966		145	145	1260	113	475	290	5 529
Active storage	Mm ³	122	1695	1191	22	145	145	1260	113	475	290	5 529
Full Supply Level	m a.s.l.											
Min. Operation Level	m a.s.l.											
Surface at FSL	km ²	21		288		12.0					0.3	306
Net Head ¹⁾	m										350.0	
Dam height	m	40	35	42	36	70					40	
Plant capacity ¹⁾	MW	6.3	25	36	1	40					500	640
No. of turbines		2	3	3	1	2					2	
Energy	GWh	17	56	90		59					400 (?)	302
Sim. energy ²⁾	GWh											
Irrigation	Hectare	32 000	40 700	24 000		9 600	10 097	50 416	12 800	29 728	22 000	199 341

Ref. EGAT website and JICA/MRC- Paper IV [9]

Pump storage

3.4 Reservoirs in Vietnam

In Vietnam there are two existing and many planned power stations on Se San, see Table 3-6. The hydropower projects have been selected based on the preliminary National Hydropower Plan [10]. There exist only two hydropower power station in the basin within Vietnam, the large Yali HPP and Dray Linh. In addition there are two projects under construction; Se San 3 and Se San 3A, However, only Yali has an active storage above 100 mill.m³. The other project is not included in the analyses. In addition, there exist several small reservoirs for irrigation purpose which in total has a capacity of approx. 100 mill.m³.

Because the average flow is known but not the variation in inflow the variation has been estimated by using the monthly inflow data from the Ban Signo gauge station, but each month is correlated by monthly distribution in Se San given in [6].

Table 3-6 Storage Hydropower projects in Se San and Sre Pok, Vietnam (projects in bold are included in the 2010-scenario). PS! The sum includes the other smaller projects (active storage less than 100 mill.m³)

		Se San:				Sre Pok:		
Reference No. In Map		38	39	40	41	42	43	
Power plant		Yali	U. Kontum	Pleikrong	Se San 4	D. Xuyen	B. Tou Srah	SUM
Completed	year	1999						
Average inflow	m ³ /sec	251	15.1	126	326	39.1	102	
Total storage	Mm ³		174	1344	893	1811	787	5 576
Active storage	Mm ³	779	123	1022	470	484	483	3 589
Full Supply Level	m a.s.l.	515	1170	575	215	570	488	
Min. Operation Level	m a.s.l.	490	1146	550	205	563	468	
Surface at FSL	km ²			8.6	64.6	58.4	81.2	37.1
Net Head ¹⁾	m	198	855.6	60.0	65.8	121.2	47	
Dam height	m	77	76	72	75	84/72	83	
Plant capacity ¹⁾	MW	720	220	110	330	100	84	2 461
No. of turbines		4	4	3	1	2	2	
Energy	GWh	3500	301	1349	142	334	358	11 783
Sim. energy ²⁾	GWh	2784	822	396	443	329	209	7 315
Resettlement	persons		1500		1550	755	2012	15 041
Reservoir-%			26 %	26 %	5 %	39 %	15 %	

Ref. Power Sector Strategy Study, by Electrowatt-Ekono and PA Consulting Group, Sep.-02.

Ref. National Master Plan, 2004 and Se Kong - Se San and Nam Theun River Basins Hydropower Study, by Halcrow, Jan.-98.

1) Efficiency curve is estimated based on expected normal values. Based on Net head and general layout the head losses and tailwater level is generated

2) Given inflow. Inflow record is based on monthly flow at Se Kong outlet and later reduced by 8%.

3.5 Reservoirs in Cambodia

In Cambodia there are at present no existing large reservoirs. The construction of Prek Thnot multipurpose dam has been interrupted since 1973 due to the political unrest in the country as well as the financial situation. Kirirom I (12 MW) is the only hydropower plant in operation at present, but the station is a run-of-river project. On Se San and Sre Pok there are several plans, see Table 3-7. Because the average flow is known but not the variation in inflow the variation has been estimated by using the monthly inflow data from the Ban Signo gauge station, but each month is correlated by monthly distribution in Se San given in [6].

Table 3-7 Storage Hydropower projects in Se San and Sre Pok, Cambodia. (no projects are included in the 2010-scenario).

Reference No. In Map		44	45	46	
Power plant		L. Se San L	L. Se San U	L. Sre Pok	SUM
Completed	year				
Average inflow	m ³ /sec	408	367	307	
Total storage	Mm ³				
Active storage	Mm ³				
Full Supply Level	m a.s.l.	80	120	70	
Min. Operation Level	m a.s.l.				
Surface at FSL	km ²		6.4		6
Net Head ¹⁾	m	18	25.0	18.0	61
Dam height	m	30	35	30	95
Plant capacity ¹⁾	MW	185	153	205	543
No. of turbines		4	3	4	11
Energy	GWh	921	800	1153	2 874
Sim. energy ²⁾	GWh	425	443	212	1 081
Resettlement	persons			2676	2 676
Reservoir-%					

Ref. Report analysis of Sub-Area 7V, BDP, July 2003

"L"=Lower, "U"=Upper

3.6 Summary of reservoirs in Mekong

The sum of active storage in each country and in total for all countries are presented in Table 3-8.

Table 3-8. Active storage in the Mekong basin.

	China	Laos	Thailand	Cambodia	Vietnam	SUM	NT2-portion
Present	257	5 194	5 529	N/A	888	11 868	
2010	10 524	12 949	5 529	N/A	921	29 923	12 %
2025	23 193	22 608	5 529	N/A	3 589	54 919	6 %

JICA [9] has summarised the present total (active?) capacity of large –scale reservoirs in the entire Mekong Basin to 12,147 mill.m³. Average annual flow volume of the entire Mekong basin is 475,000 mill.m³.

The active storage created by other water users than hydropower is small. An exception is the reservoirs in Thailand of which 2000 mill.m³ is storage made with the only purpose of irrigating paddies. The remaining 3500 mill.m³ are used both for hydropower and irrigation.

The extractions of surface water by pumping stations are comparable small. In sum, only 18 m³/sec and 1.5 m³/sec are withdrawn from Mekong in Thailand and Lao PDR, respectively. [9].

4 FLOODING

The floods in upper Mekong and tributaries to Mekong are normally created by rain storms lasting for some hours or a few days at most. They are difficult to predict, but only a small reduction of water level in the reservoirs could halt the flood. Since most available inflow records are monthly data a flood event of only a few days could not be simulated for the whole basin.

Normally the floods are reduced by dam structures. There are two reasons for this:

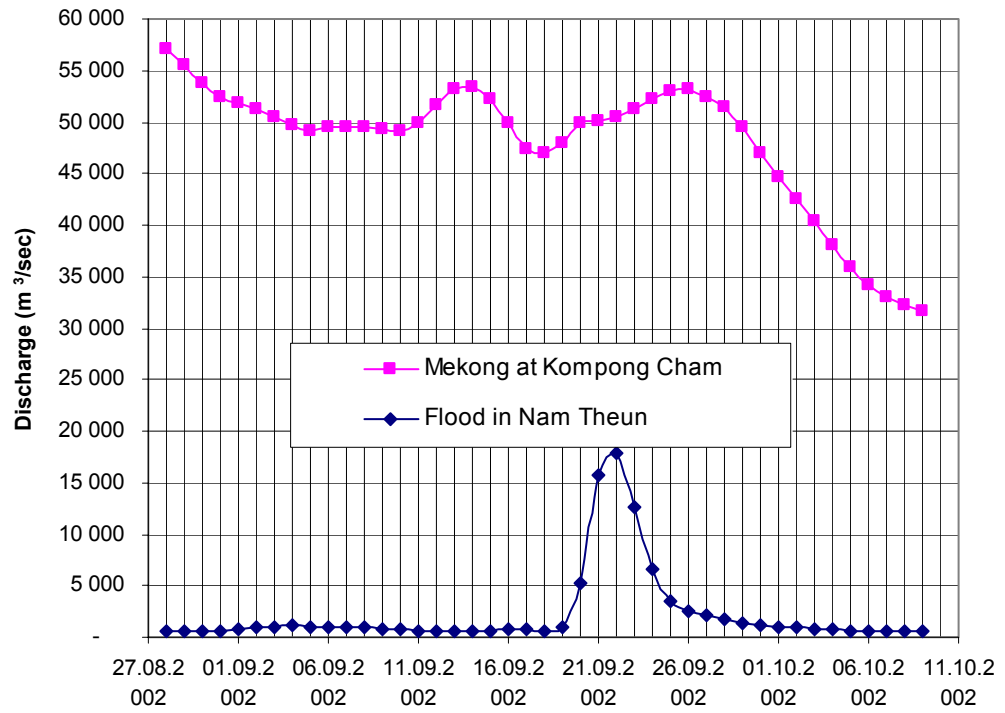
1. The reservoir is not full and flood events during in particular the first period of the wet season will be “trapped” by the reservoir.
2. The reservoir is dampening the flood because of surcharging between full supply level and maximum flood level.

The dams might however increase the flood in rivers further downstream if the flood from the area normally passes before the peak flood occurs in the main river. This might be the case for Nam Theun and Mekong. Although the size of the flood from the tributary will be reduced due to dam construction, the flood might be prolonged, the peak could be delayed and come on top of an existing flood in the main river.

By comparing the daily record for Nam Theun (1998-2002) with the record from Mekong just upstream Tonle Sap (1966-2001) the annual maximum discharge in Nam Theun might as well occur before the maximum level in Mekong as after the maximum level. The floods in Nam Theun may be characterises as typical flush floods compared to the slowly changes in Mekong, see flood occurring in Sept. 2002 (approx. $2.0 \text{ m}^3/\text{s km}^2$) plotted in *Figure 4-1*. Extreme floods incidents recently in other tributaries to Mekong was Se San $1.2 \text{ m}^3/\text{s km}^2$ on 3 Nov. 1996 and Sre Pok (Krong Kno) $1.3 \text{ m}^3/\text{s km}^2$ in 2000 [11].

The extreme flood in Nam Theun had an impact on Mekong, but since the base flow in Mekong was on the way down a delay in the flood (caused by NT2) would also reduce the flood in Mekong. The peak flood in Nam Theun may occur both before and after the peak flood in Mekong. Hence, if the flow in Mekong is increasing, a delayed flood from NT2 might increase the flood in Mekong. If the flow in Mekong is decreasing the NT2 will reduce the flow (compared to the natural situation)

Figure 4-1. Daily discharges for Mekong just upstream Tonle Sap and the discharge in Nam Theun, during a high flood in Nam Theun.



REFERENCES:

- [1] “Sustainable development of Lancang –Mekong river basin and integrated multiobjective utilization research of water resources” by He Damming, Yunnan Institute of Geography and Zhang Jiazhan, Beijing Institute of Geography.
- [2] “Water Resources Simulation Model of the Lancang River (in Yunnan Portion of China)” by Liu Hong, Nanjing Institute of Hydrology and Water Resources.
- [3] “The potential impacts of hydropower developments in Yunnan on the hydrology of the Lower Mekong” by Dr P.T. Adamson, Halcrow Water.
- [4] “Power System Development Plan for Lao PDR” by Meritec Ltd and Lahmeyer GmbH, March 2004.
- [5] “Power Sector Strategy Study”, by Electrowatt-Ekono and PA Consulting Group, September 2002.
- [7] “Power system Planning in the Ministry of Hydropower and Handicraft” by Knight Piesold, Draft Final Report, September 1997.
- [8] “Se Kong – Se San and Nam Theun River Basins Hydropower Study”, Interim Report, Volume 1, by Halcrow, January 1998.
- [9] “The Study on Hydro-meteorological monitoring for water quantity rules in Mekong river basin”, Paper IV Preliminary check of changes in low flow regime on Mekong mainstream and Major Tributaries, by JICA and MRC, February 2002.
- [10] “National Hydropower Plan Study”, Stage 2, phase 1, by SWECO, NORPLAN et al, April 2004.
- [11] “Analysis of the Sub-area 7V. Basin Development Plan”. By Institute of Water Resources Planning and Vietnam National Mekong Committee, Hanoi, July 2003.

ASIAN DEVELOPMENT BANK

**CUMULATIVE IMPACT ANALYSIS
AND NAM THEUN 2 CONTRIBUTIONS**



Annex 4: Fish Biodiversity and Fisheries

Prepared by: Terry Warren

November 2004

TABLE OF CONTENTS

- 1 INTRODUCTION.....1**
- 2 MEKONG FISH BIODIVERSITY AND ECOLOGY1**
- 3 POTENTIAL IMPACTS OF HYDROPOWER.....3**
 - 3.1 Species Composition3
 - 3.2 Impacts form Hydrological Changes4
- 4 FISHERIES5**
 - 4.1 Mekong Resources5
 - 4.2 Staple diet6
- 5 NT2 NAKAI HIGHLAND RESERVOIR.....6**
- 6 XE BANG FAI7**
- 7 NAM KADING AND NAM HINBOUN.....8**
- 8 GREAT LAKE9**
- 9 MRC STRATEGY FOR FISHERIES MANAGEMT 10**
 - 9.1 Institutional Strengthening.....10
 - 9.2 Capacity Building11
 - 9.3 Compensation and Mitigation.....12
- 10 FISH PASSES AND FISH MIGRATIONS IN THE MEKONG BASIN..... 12**
 - 10.1 Cases14

1 INTRODUCTION

Large rivers worldwide play an important role in any single nation's ecology, economic status, social latticework and cultural background. Large rivers must be viewed as a multiple-use resource providing support for a wide and diverse range of industries and activities. These include navigation, fisheries, irrigation water supply, transport, power production, and support to various industries and recreation. By their very nature, not all the above mentioned uses are mutually compatible, and conflicts between "users" and various resource stakeholders are commonplace worldwide.

Large rivers provide important social and economic benefits to the populations of both the "developed" and "developing" nations. The fisheries that large rivers support represent a source of food, employment and income worldwide, often for the poorest sections of the community. Large river fisheries are considered to be universally under-valued, and often are not given the priority they deserve in river basin management planning.

During the past 100 years or so, various endogenous and exogenous factors, together with many different anthropological interventions, have brought about a degradation of many large riverine habitats, and freshwater fisheries in particular. Because of the complexities associated with these changes, solutions in terms of management practices, conservation, restoration and rehabilitation of degraded large river systems dictate that a multi-disciplinary approach be adopted. Experts in the fields of ecology, conservation, fisheries biology, hydrology, limnology, engineering and geology are required to work together to formulate optimum management strategies for large river systems and their respective fisheries.

Large rivers [such as the Mekong], and their associated wetland habitats, support a significant part of the world's aquatic bio-diversity. Sustaining bio-diversity and fisheries in large rivers require that habitat management and exploitation management be considered in parallel.

Given that millions of people living in the LMB that rely on fisheries for one reason or another might be affected by water-related infrastructure development, it is essential that Mekong Basin development be analyzed and assessed from a holistic point of view. Whereas isolated projects require their own EIA's to focus on localized impacts on fisheries, and the problems that these may cause to riparian communities, what is required for a broader view for the entire Mekong Basin is a cumulative impact assessment (CIA study), to which this ADB funded study is a contribution

2 MEKONG FISH BIODIVERSITY AND ECOLOGY

The Mekong is rated as the world's 12th longest river, and is placed in 8th position in terms of flow volume. Its fish bio-diversity is outstanding, and may eventually surpass any of the other river basins that have been studied worldwide, where data have been collected on fish bio-diversity.

There are an estimated total of about 1,200 fish species found in the Mekong Basin. The number of recognized and described species is increasing every year, as taxonomic and classification experts are able to gain access to remote areas and collect samples from hitherto unexplored habitats in mountain streams and

other upland regions. Even large species, of up to 20 kg in weight, have only recently been scientifically described from the Mekong basin within the last decade [REF]. There are undoubtedly more fish species to be discovered and reported on in the scientific literature. Most or all of these species are almost certainly known to local people, and have local names, but some are as yet not known to science.

As with most, or perhaps all other freshwater fish communities, the resident fish fauna of the Mekong Basin is dominated by the Cyprinidae [carps] family. Other important families include Osteoglossidae [featherbacks], Clupeidae [herrings and anchovies], Siluridae [catfishes], Sisoridae [catfishes] and Pangasiidae [catfishes] and a large number of other families with their associated genera and species

There are a large number of catfish species families and groups in the Mekong Basin region. Typically, “catfish” are assumed to be bottom-dwelling species, and it’s true to say that many are (but not all species). Some Pangasid species are predatory (eating other fish), and some graze on algae and its associated biota. Some species eat fruits and flowers on a seasonal basis when they are available. Some species of the Pangasiidae are carnivorous only, and only eat live, dead, or decaying prey items. Other “catfish” species are active predators and consume a wide range of prey-items, including prawns, crabs and other fish species (Silurids, Bagrids, and members of the Sisoridae genus).

The indigenous and scientific knowledge surrounding what actually governs the fish production in all of the Mekong’s diverse range of habitats (Mekong main-stream, tributaries, the Great Lake in Cambodia, small rivers and seasonal back-swamps) is limited to say the least. Our knowledge of migratory patterns, fisheries ecology and biology of many species is fragmented and poorly understood in many cases. However, some models do exist that try to incorporate all aspects of Mekong fisheries, and the likely effect(s) that water-related development may have on the future of this resource.

The Mekong owes its rich fish bio-diversity mostly to the annual variation in extreme flow patterns and climatic changes throughout the different seasons. This involves periods of the flood-pulse, and also when waters begin to recede at the end of the rainy period, allowing other processes to take place, including the re-oxygenation of nutrients in floodplain areas. The annual flood-pulse physically moves aquatic organisms and their juveniles into appropriate areas where they can complete their life-cycles [flooded forests, floodplains, mangrove swamps and, in some cases, into lower areas such as the Mekong delta in Vietnam]. An annual re-generation of phyto- and zooplankton populations as a result of the release of oxidized nutrients, supplies the basic food-fuel required for almost all of the aquatic biota associated with the food chain, and upon which many people ultimately rely on for their livelihoods in terms of Mekong fisheries.

Most migrations of animal populations, including fish, are cyclical in nature. This requires that the adults of most species return to other habitats and environments where they can carry other essential and critical life-cycle events. Some species of Pacific Salmonids for example, simply die after completing their migratory route to remote areas in Northern American streams from the marine environment. Many have spent a number of years feeding and developing into adult fish thus enabling them to return to riverine environments where they can eventually spawn. Their death contributes to the nutrient chain and, following their bodily decomposition, this provides food for juveniles. To our present knowledge, no

such processes occur with Mekong fish species, but the Mekong basin fish species are always full of unexpected surprises and uncertainties.

Fish migration is difficult to define. Some freshwater species only need to move a few meters to spawn and / or feed from their current environment. Other species make a journey of hundreds, or even thousands of kilometers, to enter the habitats necessary for them to carry out critical life-cycle events that enable their populations to continue. It is probably safe to assume that ALL species of Mekong fishes are migratory to one extent or another. It just depends on who is describing a migration, or what is being precisely defined.

The Lao PDR, within the Mekong catchment zone [including the upland areas], **may** represent the most important country in S.E. Asia in terms of fish biodiversity, but this is difficult to substantiate at present. Hydropower, irrigation and other forms of water-related development will almost certainly have an influence on this, but accurate predictions are difficult to make.

3 POTENTIAL IMPACTS OF HYDROPOWER

3.1 Species Composition

Hydropower development expected to have some effect on fish production, both locally and regionally (lower LMB countries). Giant species (mentioned above) are already under threat for various reasons other than by further hydropower development in the Mekong Basin. Several species (about 10) are already at the “economically” extinction phase of their existence, but only a very few are at their “biologically” extinction phase (perhaps up to around 4 species).

Concerning hydropower project, there are some main groups of fishes that may be affected, both locally, and regionally.

Generally smaller fishes dominated by the Cyprinidae family (carps) that use eyesite to locate their food items in the relatively clear waters of the dry-season months. They typically have large eyes, and occupy the middle to upper parts of the water column (but not always). These may decline in number if re-suspension of base sediments is caused as a result of water-discharge during the dry-season months.

Some reservoirs in Thailand (Ubolratana for example) and the Nam Ngum reservoir in the Lao PDR have developed large populations of small pelagic species (*Clupeichthys* spp.). These species (two) occupy the “pelagic zone” of the two above-mentioned reservoirs at least and probably many other reservoirs throughout the region of S.E. Asia. They are not only important as a staple diet for riparian / reservoir predatory fish populations, but they are a source of protein for more lucrative aquaculture operations, such as the net-cage culture of expensive, marketable species.

Most species of fish do not occupy the pelagic zone of reservoirs, but thrive in marginal zones around the edges of reservoirs to a depth where oxygen becomes a limiting factor (typically around 10 m in tropical Asian reservoirs), but this varies depending on locality.

3.2 Impacts form Hydrological Changes

There are concerns that river regulation and the changes in the hydrological regime may have negatively impacted on fish populations, by preventing migration, or preventing access to, and escape from flooded plain areas and thereby causing damage to fisheries. Furthermore, fisheries may have been impacted already by pollution, such as from pesticides usage in irrigated tail-waters and from other sources.

The fish populations of the Mekong Basin have evolved and have diversified in a range of environments and habitats over hundreds of thousands of years. The specific habitats include the Mekong mainstream (and its “deep holes or pools”), tributaries, rapids, floodplains, and flooded forest areas with a range of variable base substrates. Natural variation in the annual hydrological conditions due to rainfall patterns causes a change to the size of species-specific fish population level. During years when rainfall is higher than normal, this causes a greater inundation of otherwise dry land in the floodplain areas. This in turn increases the available habitat for feeding and spawning. For some short-lived early-spawning species, the effects of a “flood year” can sometimes be observed relatively quickly. For other, slow growing, large species, the effects of a “flood year” may be delayed for some while, but not always so and not necessarily so.

Permanent changes to Mekong hydrological patterns will undoubtedly have an effect on fisheries production throughout the basin. It is a biological and ecological certainty. The main current threats to alterations in the Mekong hydrological pattern appear to be mainstream and tributary large storage dams for hydropower generation and for irrigation. The excessive abstraction of water for dry-season agriculture may be beneficial under some circumstances. Channelization, in whatever form it takes, can be highly damaging to fisheries. Channelization, including the destruction of rapids for the purposes of large vessel navigation may prove disastrous. Deforestation is a worldwide problem and has severe consequences for many river habitats, and the aquatic species that live there.

Since the absurd plans of the 1960’s and 1970’s intending to build the Mekong mainstream “cascade” (involving a large number of storage dams for hydropower development) have now been abandoned, the situation now looks much better for future mainstream and Great Lake fisheries. The construction of the mainstream Manowan dam in Yunnan Province in Southern China, and the near completion (or completion) of one more mainstream dam may have some consequences for downstream fisheries production in the LMB countries. However, they are at least “run-of-river” projects (although no such real thing exists in reality), and therefore the impacts that accrue from them are likely to be less than if large storage dams are built in the future.

Due mainly to the lack of English written literature from China, we are not certain about the migratory movements of fish in Yunnan Province, and how these relate to the LMB countries. However, through personal conversations with a number of experts, they are probably small in comparison to the annual migrations taking place in the Mekong in the Southern part of the Lao PDR, Cambodia, and between the Cambodian Great Lake and the Mekong mainstream via the Tonle Sap River.

Where migration routes cross international borders, stock-management becomes a trans-boundary issue and requires international cooperation. With the adoption of policies on decentralization, the four MRC member countries have taken steps

towards integrating management-intervention, which is crucial for the effective management of migratory fish stocks.

As I have attempted to explain in this brief document, it is near to impossible to realize any “near-accurate” figures concerning “catch” and “catch opportunities” in the rivers that will be impacted by some of the various hydro-development schemes in existence. Or the ones being planned for the Mekong region (NT2-XBF and the Theun-Hinboun projects, to mention just a few).

4 FISHERIES

4.1 Mekong Resources

Fish probably represent the most important component of the family protein requirements of the rural populations of S.E. Asian countries. As much as 2 million tonnes are estimated to be harvested on an annual basis in the Lower Mekong Basin (LMB) countries. However, other aquatic animals also need to be taken into consideration. These include reptiles, amphibians, crustaceans, and others that exist, and rely on the Mekong’s various seasonal habitats during the wet and dry periods for their continued existence and survival. In some cases, the life-cycles of the various species involved are not clearly understood, and some are poorly documented in scientific literature.

In terms of livelihoods, the Mekong River supports the life-requirements of some 70 million people. This figure also includes the various industries associated with the direct capture of fish, whose income relies on the fishing industry in general. The “fisheries” industry can be divided up into various categories and components. These include the fishing communities themselves, fish processing operations, marketing, law enforcement organizations, transport and various other sectors.

As noted above the present fisheries yield of the Lower Mekong Basin are thought to be around 2 million tons per year. The estimate is: 500,000 tons for Cambodia; 133,000 tons for Lao PDR; 795,000 tons for Northeastern Thailand; and 597,000 tons for Vietnam. The first hand value is calculated to be about US\$1,478 billion per year. FAO statistics indicate a steady increase in the fish yield in all lower Mekong countries during the period from 1988 to 1993. It seems however, that the stock is currently being utilized close to, or above the production capacity. The data on fish populations and catch is by nature uncertain, but there are indications that an over-exploitation of fisheries resources is in process. These include a decrease in the average size of some of the larger fish species being caught that form part of the international-trade and local commercial fisheries.

The fisheries sector, and its development and sustainability has always been, and will remain, problematical for the countries of the (LMB) in S.E. Asia. Unlike the forestry, agricultural and other sectors, fisheries and the trends they move towards, are difficult to monitor, manage and control. This is particularly so when river systems are co-managed by a number of different countries through which any particular river passes. The central governmental and the political policies regarding the management of the fisheries sector of one particular country, are not necessarily agreed to, and supported by the all the countries of the region.

Historically, this had led to a level of dispute and conflict between the countries that connect with each other via the Mekong River in S.E. Asia.

Assessing the aquatic resources of large deep rivers, and the monitoring of their quality and sustainability, is difficult because of the nature of all the factors that control them (physical, political, anthropological, ecological, environmental and climatical). The problem is compounded by the fact that the Mekong River is a host to a large number of trans-boundary migratory fish stocks. Anthropological exogenous and endogenous factors over the past few decades have altered the hydrological patterns in the Mekong and its tributaries. This has caused changes to resident biota, historical fish migration routes, river-side dry-season horticulture / agriculture, and the riparian natural plant population communities that interact with the various aquatic communities.

4.2 Staple diet

Fish is an important part of the staple diet, and the most important source of protein in the Mekong Basin. The average basin consumption of fish is 36 kg / person / year. This varies from 20 kg / person / year in the mountainous zones to around 60 kg / person / year in the flood plain areas of Cambodia and Vietnam. The Great Lake of Cambodia is amongst the world's most productive freshwater fisheries region, representing about 60 percent of Cambodia's total freshwater fisheries annual catch.

Aquatic production far outweighs all other sources of the basic protein and other nutrient requirements in the lives of S.E. Asia's rural poor populations. This is not only limited to fish-catch alone, but also includes crabs, frogs, prawns, snails, snakes and certain aquatic weeds. Disruption to this production may have profound implications for food security issues, and the eventual political and social stability [or instability] of the LMB countries.

Based on my own personal observations and information, it should be stated that the above estimates for fish consumption of 20 kg / person / year (mountainous regions) and 60 kg / person / year (floodplain zones) are probably underestimates from Mekong Basin wilderness fisheries.

The Government of the Lao PDR is well aware of the importance of wilderness fisheries to local economies and food security issues. These have to be balanced, and weighed against, the benefits that come from water-related development projects. Evidence to date suggests that all aspects are being considered.

5 NT2 NAKAI HIGHLAND RESERVOIR

The Nam Theun is host to a cold-water fish fauna. Many of these species also occur in lowland habitats, but some species are new to science, and have yet to be fully described and reported on in scientific literature.

The construction of a reservoir involves a conversion of a lotic (flowing) system into a lacustrine one (static). This may particularly have an affect on some rheophilic species (those fish species that require flowing water to complete their life-cycles). Certain species will have no problem in adapting to the new "reservoir" conditions and will likely proliferate and dominate the species composition. These will include a number of Cyprinid species, and also the labyrinthine group of species including Snakeheads (*Channa* spp.), Climbing Perches (*Anabas testudi-*

neus) and several species of Gouramy (*Trichogaster trichopterus*, *Trichogaster trichopterus*, *Trichogaster microlepis*, *Trichopsis pumila*, *Trichopsis vittata* and *Osphronemus exodon*). A number of other species will also thrive and survive in the reservoir. These include a whole range of small species from the *Rasbora* genus and several other genera. The effect that NT2 will have on prawns, frogs, crabs, snakes and other aquatic animals, that also form part of the diet of the Lao rural population, is uncertain on the Nakai Highland. It may increase, or decrease in availability. Irrigated land during the dry-season months may favor the production of strictly non-fishery (fish) protein production for human exploitation.

6 XE BANG FAI

The additional discharge of about 280 m³/sec of water into the XBF has the potential to be damaging to fisheries, particularly during the dry-season months. During this period, this may cause the erosion of riverbanks and the re-suspension of base substrate material (sand, silt and base muds). This has the potential to smother important primary production elements that form an essential part of the diet of many fish species during the dry-season months. Erosion effects, and elevated water levels, may also cause damage to certain plant species that have become established on the rocky outcrops both within, and along the riverbanks of the XBF. Some of these plant species undoubtedly form an important part of the ecological association between the river and various aquatic animal populations. This may ultimately negatively affect fish production. This has probably already taken place at the Theun-Hinboun Project, but cannot be adequately assessed and reported on.

There is a possibility that NT2 will discharge polluted [thermal and chemical] water into the Xe Bang Fai (XBF). This is particularly a potential threat to the XBF if the NT2 reservoir is not cleared of vegetation prior to the dam being closed. However, given that the total clearance of vegetation is not likely to take place (apart from the extraction of expensive hardwoods), the problem may be mitigated to some degree by fitting a variable water intake at the dam and provision is being made for a re-oxygenation weir below the powerhouse. This is being planned at NT2.

Impacts to fisheries must be expected as a result. Many species of fish rely on the annual production of a filamentous algae species (or perhaps several different species) that develop on hard and soft substrates during the dry-season months. It [or they] only appear during the dry-season months, because light can penetrate the relatively clear, shallow waters. This provides the “food fuel” for many species of fish to build up the necessary fish reproductive products (eggs and sperm), and also provides the necessary energy to enable fish to undertake migrations. Not all fish species utilize it, but many do. Those that do not use it are in many cases predatory species, which of course rely on the availability of the prey species to complete their life cycles.

Having “gorged” on this for 3, 4 or 5 months, they are then ready to migrate to their many different critical environments for spawning. When the seasonal rains arrive in May and June, that continue until about October each year, the filamentous algae dies [because of water turbidity and reduced light penetration], and the material joins the detrital food chain. This provides food for other species that are “bottom” dwellers [some Cyprinids and various species of catfish, including Pangasids, Bagrids, Silurids and other fish families].

Fish rely on certain physical and chemical factors concerning the annual rise and fall of the mainstream and tributary waters to gauge their movements (migrations). The additional discharge of water into the Xe Bang Fai may cause migratory disorientation, and cause fish to move prematurely on an annual basis. Initially, this may appear to be a positive impact, because more fish may be caught out of season. But when the system reaches a new equilibrium phase, the overall production of fish may be less due to disruption of natural habitats and normal conditions. These include perturbations to spawning and feeding habitats brought about by non-seasonal flow patterns and natural hydrology. Any seasonal deviation in flow regime will almost certainly have an effect on fish production.

Fish populations have evolved in alliance with natural conditions (forests, floodplains, water flows and flood-pulses etc.). Disruption to any of these elements will have some effect.

Also the issue of “thermal pollution” needs some consideration. The Nam Theun is a “cool water” river, because of its high elevation. The sections of the XBF that may be affected by the NT2 are warm in comparison to many upland streams and rivers. Fish, being poikilotherms (cold-blooded animals), rely on ambient water temperature to grow and carry out their normal bodily functions. There may only be a minimal effect in the XBF, because the water discharged to the XBF will have been stored in a shallow reservoir (Nakai Highlands), and will traverse a 27km channel before being discharged into the XBF. Both the above factors could mean that water temperatures in the XBF might remain more-or-less the same given the seasonal variation that exists anyway.

The current, ongoing, pre-impoundment fisheries study concerning the XBF (financed by NTEC) aims to look at a RELATIVE index of abundance of fishery resources. This is to say that it will try to compare pre- and post impoundment levels of relative fish catch using a technique known as Catch Per Unit of Effort or [CPUE] used as an abbreviation. The pre-impoundment study is due to be completed in the year of 2006, and will result in a final report in addition to annual reports summarizing the data collected during each year.

The CPUE data are being collected from 21 fishers in seven different villages throughout the anticipated “Impact Zone of the lower XBF”. A reliable “fish production figure” is unobtainable for a river such as the XBF, because of the seasonal movements of fish during their annual migrations. Apart from a few species that do not appear to migrate over large distances at least, a “standing crop” (kg / ha / year) is impossible to calculate, and does not exist in reality. The so-called “standing crop” moves all the time. Sometimes it is in the XBF, sometimes it is in the Mekong, and sometimes it is in the Mekong floodplains and flooded-forest areas of Cambodia and elsewhere. The factors that actually affect the available “fishery production” in the XBF are dependent on a huge number of variables, and are way beyond the confines of the XBF itself, and its surrounding landscape. This is why the relative index of CPUE is being used.

7 NAM KADING AND NAM HINBOUN

The Nam Kading refers to the section of the Nam Theun that extends from the Theun-Hinboun dam to the river’s confluence with the Mekong at Pak Kading in central Lao PDR. The river meanders from the Mekong confluence for approximately 30km, as if it were a “normal” lowland tributary, before it starts its ascent to the Nakai Highlands. It is within this section of the river that conditions begin to

change. Huge sections of rock have toppled down from their ancient sedimentary bases higher up the valley, and now partially block the river's flow in some cases. This has created a special habitat for a range of fish species and other aquatic animals and plants. In addition to water entering this environment, it is cool in comparison with rivers flowing along the Mekong floodplains, such as the Nam Hinboun, Sekong and many other Mekong tributaries from the LMB countries. There are sections of rapids and riffle, and deep pools throughout the section of the Nam Kading that extend up to the Theun-Hinboun dam.

At the onset of seasonal rains in late April or May, many fish embark on their upstream spawning migrations in the Nam Theun and other Mekong tributaries. The fish come from the Mekong itself, and also from dry-season refuge habitats within the Nam Theun (deep pools). They move upstream to unknown spawning locations, but possibly as far up as the Nakai Highlands. They certainly reach the Theun-Hinboun dam, as I personally witnessed in April / May 1998. Huge numbers of fish (some of them large, and estimated to weigh up to several kilograms) are gathering below the dam crest, and clearly trying to get by it. Only under exceptional circumstances (flash-floods) can a very limited number of fish pass over the dam.

Because there is no provision at Theun-Hinboun for a return route for juvenile fish to return to the Nam Kading for population recruitment, fish populations have probably been badly impacted below the dam, all the way to the Mekong confluence. There is a major Nam Theun tributary approximately 40km downstream of the Theun-Hinboun dam, the Nam Mouan. It is just possible that if some species are not able to pass the Theun-Hinboun dam, these adult fish may return downstream and enter this tributary for spawning. The problem is that not enough knowledge is known about the "homing" behaviour of S.E. Asian fish in large tropical rivers such as the Nam Theun.

8 GREAT LAKE

It is assumed that NT2 will have an insignificant impact on fisheries bio-diversity in the Great Lake of Cambodia. Given that less than, or approximately 1% of the average inundation area may be affected, fish species bio-diversity should remain intact. As previously mentioned, the reasons why certain species are in decline, are way beyond, and not confined to hydropower development in the Mekong Basin at its present level. There is a potential threat to fisheries, and fish-bio-diversity if there is non-regulated, and poorly thought-out hydropower sector development. Upstream countries must consider the effects that their immediate development requirements might have on LMB countries, and the Mekong Basin and its fishery, which is clearly important in the lives of millions of people.

Several "giant" fish species are occasionally caught in the Bagnet [or Dai] fishery as they exit the Great Lake of Cambodia on their annual migrations, along the Tonle Sap River that connects the Great Lake to the Mekong at Phnom Penh. Some examples of these species include: *Catlacarpio siamensis*, *Pangasianodon gigas*, *Probarbus jullieni*, *Bosemania microlepis* and others. These fish are late maturing species, and have been in decline for many years now for various reasons other than hydropower development. This is probably mostly due to over-fishing with gillnets together with a general degradation of habitats, including the areas where they spawn. What appears to sustain the productive fishery of the Cambodian Great Lake is the reproductive capabilities of small, early maturing species. These fish often become sexually mature within one year and hence can

be harvested on a regular (annual) basis, but typically these stocks appear to remain intact. This is a common feature in many “fisheries” (marine and fresh-water) worldwide.

There is no evidence to-date that production in the Great Lake of Cambodia is in decline. Species compositions appear to be changing, but overall production (around 235,000 tonnes / year) seems to be the same as it has been for the past 20 or so years at least.

Fish “standing crop” estimates for the Great Lake vary considerably and range from around 139 kg / ha / year (Van Zalinge *et al.*) and further estimates by the Mekong River Commission (MRC) of 205 kg / ha / year to later figures of up to 330 kg / ha / year. In addition there is the question about how strong correlation exists between the lake area and the fish production and finally fish catch. It is therefore impossible to accurately estimate what the impact on fisheries caused by changed hydrological conditions.

The impacts of potential 20-year development are even more difficult to predict from a fisheries point of view. The status of fisheries in the LMB countries will be dependent on what further developments in terms of water-related projects take place both within the LMB countries and further upstream in Yunnan Province in China (the Mekong mainstream Hydro-cascade) and the Langcang Navigation Project to aid shipping through rapids. The latter project may send much larger volumes of water more quickly into the LMB countries during the wet-season months, and has the potential to cause increased flooding in the Mekong delta region of Vietnam. Also, it has to be said that this may partially compensate for water retention (Hydro-Irrigation) schemes that represent a potential threat to fisheries in the Great Lake of Cambodia.

9 MRC STRATEGY FOR FISHERIES MANAGEMENT

Within its Fisheries Programme, the M.R.C.S. has produced a strategy and an outline of a programme for an integrated fisheries management and development program. This is intended to cover both capture fisheries and aquaculture. The strategy emphasises the basin wide needs and benefits of structural, institutional, and human resource development efforts.

9.1 Institutional Strengthening

This will have to take place at different levels; local; district, provincial], and central / ministerial. The way forward is to begin at the local level, and then get it accepted at the provincial level and then seek approval at the central / ministerial level. There are many examples where this appears to have worked. Also, there must be a close association between resource “users” (fisher people in this case) and at the / District / Provincial level. Under a co-management situation, whereby local people [villagers] feel they can have a “voice” and can communicate with authorities [District and Provincial], this represents an essential component in any development process. Villagers are always the ones who ultimately represent the managers of natural resources.

What is initially required is a statement of the problems that need to be addressed and accurately identified, usually at the local level. There is an urgent need to clearly define the objectives of field and other forms of research, which has not always been the case in the Lao PDR. But the situation is now changing,

particularly as talented graduates in fisheries, and other areas, are returning from educational institutions within the Lao PDR and from overseas.

Training can be provided from external sources [resource management experts], and these can be brought in as and when appropriate. Also, a technical back-up system should be made available from a wide range of people who / that have specialised in certain areas (biology, ecology, engineering etc.).

One area that is particularly lacking in the Lao PDR's educational system, and is preventing talented young Lao people from conducting scientific research appears to be a lack of understanding of statistics and statistical methods. This prevents them from reporting on their findings and their significance in the scientific literature. Analysis of field data and interpretation of results from field data, is also a problem. Methods of data storage, and how to deal with it, are problematical for everyone. But it's important to decide on how the data should be analysed, before data collection begins.

9.2 Capacity Building

One way forward is for a system to be generated that allows the training of trainers [local nationals, in their own respective languages], with perhaps expatriate inputs where appropriate.

Several things that seem to be holding back scientific contributions to Asian fisheries knowledge is a lack of clearly defined objectives regarding various studies being undertaken, lack of knowledge on how to record, store, analyse and interpret data.

The lack of knowledge in basic statistics cannot be solved by "quick-fix" methods involving 2 or 3 day courses. Although this may be a starting point, an understanding of what statistics mean must be viewed in a broader context of the issues involved. That is to say, [why has this result been obtained]. There are often second, or third or more factors that can confuse the statistical result, leading researchers to think they are "on the right track". Parametric statistics are not mathematics, and are based on probabilities and associated factors. They still remain the strongest tools we have concerning examining data sets. This is a difficult issue to explain to people with little or no statistical training and background knowledge.

There is also a necessity to make sure that monitoring systems are in place in parallel with field research. Some field projects concerning fisheries have passed from a research phase [when basic things are trying to be understood] into a monitoring phase. The monitoring phase has to be something that can be achieved, and adequately reported on, given the limitations that are necessary to achieve it [budgets, human resources, geographical position etc.].

In particular, there appears to be a problem with the continuity of project fisheries staffing within the Lao PDR. This is to say that once people have gained experience in certain areas, they are then sometimes diverted to other departments or projects, where they have to "begin again". It is not my duty or responsibility to comment on this further and it is clearly a Lao issue and a subject for them to decide upon, considering what is appropriate for their needs and requirements.

9.3 Compensation and Mitigation

Hydropower and various other forms of water-related development generally have a negative impact on riverine wilderness fisheries. These also impact on the livelihoods of local rural populations, and cause a disruption to food consumption and local economies as a result. This is a sad, but an inevitable result of various “development” processes.

The means and ways of providing compensation for those villagers that are affected remains a controversial issue. Direct monetary compensation does not appear to work very well, and is anyway probably inappropriate in many cases. Perhaps the best way forward is to maybe study ways of agricultural / horticultural diversification, backed up by improved marketing methods for the products obtained from it. Dry-season irrigation schemes should also be considered and “driven” by extracting water from the Mekong mainstream and its larger tributaries. However, electrical pumps appear to be far cheaper to operate [about 50% cheaper] than diesel fuel operated units.

Mitigation procedures are difficult to define, and have anyway to be project-specific. In some cases, mitigation procedures simply do not exist. Rivers with large populations of migratory fish species rely on the linearity and continuity of riverine environments and habitats that are interconnected. If these are intact, this enables fish to move as, and when appropriate. Physical structures that interrupt these movements may create problems. Some species can negotiate some well-designed fish pass structures, but many cannot. Fish populations deprived of access to historical feeding or spawning grounds will suffer. Also included are those species that are denied access to re-distribution routes and “escape” channels when population numbers reach critical levels. One example of this is when large numbers of fish exit from the Great Lake of Cambodia, when the rains cease in late October.

10 FISH PASSES AND FISH MIGRATIONS IN THE MEKONG BASIN

Technology exists to move fish over or around concrete structures built on rivers [fish lifts etc.], but they are expensive and require a high level of commitment by experienced and skilled staff to operate effectively. This issue not only concerns an upstream migration to allow fish access to historical spawning areas, but provision also has to be made for juveniles to return to downstream areas where they can recruit to existing fish populations.

Different life-history stages of fish normally require separate habitats to optimize survival, growth and reproduction. Migration enables the necessary shifts to be made, but the distance travelled is dependent on habitat distribution and life-history stage. Migrations are usually undertaken for at least three reasons: trophic, dispersal / refuge and reproduction. Migrations may be lateral, taking place between flooded areas and the main stream, or longitudinal. Some migrations may involve a movement of only a few meters, whilst others may involve vast distances covering hundreds or thousands of kilometres. Traditionally, fish species have been categorized into migratory and non-migratory types, often based on some arbitrary minimum distance the species migrates for reproduction. However, any migration (short or long), for whatever reason, and at any life stage, may be important. Therefore, it seems more logical to regard most if not *all Mekong fish species as migratory*, albeit to different degrees of physical movement.

Water-related development projects tend to block fish migration corridors, thus preventing the necessary shift between habitats. To alleviate this, fish passage structures have been constructed at some sites in order to restore, or maintain the linearity of the riverine system. In SE Asia, only a few fish passage facilities currently exist. In Thailand, structures are in place at the Kwan Phayao, Nong Han and Pak Mun Reservoirs and at some other sites. As far as the authors are aware, no fish passage facilities have so far been incorporated into any water-related projects in Cambodia or the Lao PDR. However, a design is under consideration for the Stung Chinit Water Resources Development Project in central Cambodia, and a fish passage option is still under review at the Theun-Hinboun Hydropower Project in the Lao PDR.

Fish pass design has had a long history, dating back some 300 years (Clay, 1995). With an acknowledgement of the devastating effects that water-related development can have on migratory fish populations, the search for an appropriate design began in earnest some 50 years or so ago. Much of the early pioneering work was carried out in North America, Canada and Europe and was directed at maintaining migratory populations of salmonids. Millions of dollars have been spent on fish pass research and design for what amounts to only a limited number of species. Such research has yet to be directed at the hundreds of important migratory species found in other countries of the world, and in the tropical regions in particular.

Due to a scarcity of biological data on tropical riverine species in general, design criteria for fish pass structures in the tropics have mostly been based on educated guesswork, and the applied experiences from work on salmonids. Early designs were the so called “pool and weir” and “submerged orifice” types. Both consist of a concrete flume divided into chambers by cross-baffles. With the former type, fish are required to move over the cross-baffles with the current. The latter design requires the fish to move through an opening near the base of each chamber. The main disadvantage of both designs is that they require relatively constant flows to operate effectively, and are rather inefficient at dissipating the kinetic energy of the water flow.

A third type of fish pass is named after its original designer, Denil. The design incorporates a series of vanes on the sides and base of the flume. This has the effect of turning part of the flow back on itself, and is much more efficient at dissipating kinetic energy. However, although it has a proven track record in temperate countries, it likewise cannot accommodate widely fluctuating current flows.

A fourth design, known as the “vertical slot”, is a variation on the “submerged orifice” type. Instead of having a single hole near the chamber base, it incorporates a continuous slot from top to base of each chamber. Unlike the other designs, energy dissipation is reported to be excellent and it can operate efficiently over a much wider range of flows, and up to at least a 5 or 6 m difference in head. It has the added advantage of facilitating the movement of almost all sizes and life-cycle stages of fish at any preferred water depth. In Australia, the original fish pass structures at the Ben Anderson Barrage on the Burnett River, and the Kolan Barrage on the Kolan River in Queensland have recently been re-designed and upgraded to the “vertical slot” design. Both fish pass structures have proven far more effective than the original design, and the Ben Anderson has been declared the most successful fish pass in Australia.

Unfortunately, for projects built on tropical rivers where fish faunas are rich, and where differences in head may exceed 10 m, the options for fish pass designs

appear to be limited at present. Fish locks (or lifts) have been incorporated into various project designs in many countries, and have a good track record of success. They have the main advantage of facilitating the bi-directional movement of a wide range of species and life-cycle stages of those species. They are disadvantageous in that they require regular attendance and maintenance, and are comparatively expensive.

In Europe, the building of nature-like bypass channels is one approach, which has received attention in recent years. In essence, the idea is to create a channel that resembles a natural river or stream, which allows the fish to pass an obstruction in the river channel. However, this approach is probably not suitable or practical for large-scale high-head dams.

10.1 Cases

The Pak Mun Dam in Northeast Thailand is located close to Ubonratchathani, is built on the Mun River and was completed in 1994. The dam is of the run-of-river type, and is the first hydropower dam in SE Asia where a fish ladder has been incorporated. A recent draft report by the World Commission on Dams concludes that the fish ladder, which is of the combined pool and weir type, is not well designed and is performing poorly. The report also notes that important spawning habitats have been lost due to inundation by the head pond and that fish yields above the dam have been considerably reduced. One hundred or more fish species have disappeared from the upstream areas since the construction of the dam.

The Theun-Hinboun Hydropower Project in central Lao PDR has a 105 MW generating capacity and came "on-line" in early 1998. It is currently the Lao PDR's most important single project in terms of generating foreign exchange through electrical power sales to Thailand. The barrage is built on the Theun River, which supports a rich and diverse range of fish species, many of which are migratory. Earlier EIA reports recommended a fish pass option be investigated. However, a decision was taken not to proceed with an in-depth study of the various possibilities. As predicted, the main wet-season spawning migration in the Theun River was blocked in 1998 (Warren, pers. obs.) and compensation is now under review for those villagers that have suffered damage to their fisheries both upstream and downstream from the dam. Perhaps the greatest "loss" of all surrounds the wasted opportunity to have built an experimental fish pass at Theun-Hinboun. Even several different designs could have been test-run under "real" conditions, and built at a fraction of the total cost of the 260 million-dollar project during its construction phase. Perhaps there are valuable lessons to be learned here for the decision-makers involved with any future water-related development in any of SE Asia's river basins.





GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ANALYSIS AND NAM THEUN 2 CONTRIBUTIONS



Annex 5: Rural Landuse with Emphasis on Irrigated Agriculture

Prepared by: Garry Oughton

November 2004

TABLE OF CONTENTS

1.	PART 1: GEOGRAPHY & LANDUSE MECHANISMS.....	1
1.1	Introduction.....	1
1.2	Zonation of the Mekong Drainage Basin.....	2
1.2.1	Geographic Subdivisions	2
1.2.2	Administrative Sub-divisions	5
1.2.3	Climatic Zonation	5
1.2.4	Ecological Landscapes & Ecoregions	6
1.2.5	Future Landuse Zonation	6
1.1	Rural Landuse and Livelihood Regimes	7
1.2.6	Hunting & Gathering.....	8
1.2.7	Agriculture.....	9
1.2.8	Animal Husbandry.....	12
1.2.9	Forestry and Tree Plantations.....	13
1.2	Impacts of Landuse on Basin Hydrology	14
1.2.1	Categorisation of Impacts	14
1.2.2	Impactors	16
1.2.10	Impactees	16
1.3	Hydrologic Pathways.....	18
1.3.1	Water Loss Mechanisms.....	19
1.4	Irrigation	20
1.4.1	Irrigated Cropping Regimes	20
1.4.2	Crop Water Requirements	21
1.4.3	Irrigation System Typology.....	25
1.4.4	Irrigation Mechanism.....	33
2	PART 2: PRESENT STATUS OF LANDUSE & SHORT-TERM TRENDS	36
2.1	Introduction.....	36
2.2	Basin-wide Perspectives	37
2.2.2	Trans-basin Diversions	39
2.2.3	Predicted Impacts of Agriculture	40
2.2.4	Ongoing & Planned Irrigation Upgrading and Expansion	40
2.3	Lao PDR Perspective	40
2.3.1	Irrigated & Irrigable Lands.....	40
2.3.2	Ongoing & Planned Irrigation Upgrading and Expansion	41
2.4	Local Perspective - NT2-HPP Proximal Impact Zones	41
2.4.1	Theun-Kading Basin (14,822 sq km).....	44
2.4.2	Nam Hinboun Basin	60
2.4.3	Xe Bangfai Basin and Surrounding Districts.....	61
3	PART 3: RECOMMENDATIONS	64
3.1	Policy & Legal Framework	64
3.2	Institutional Strengthening and Capacity Building	65
3.2.1	Governmental Institutions	65
3.2.2	Non-Government, Community-Based, and Private Sector Organisations.....	67
3.3	Technical Aspects and Best Practices Leading to Sustainable Rural Landuse Intensification	68
3.3.1	Data-gathering & Monitoring	69
3.3.2	Design of Civil Works	70
3.3.3	Public Consultation & "Informed" Choice	71
3.3.4	Water Resources Infrastructure Operation & Maintenance.....	71
3.3.5	Tree Plantations.....	72
3.3.6	Best Practices for Rainfed Agriculture, Grazing, Plantation, Forestry & Conservation.....	72
4	PART 4: PREDICTED LANDUSE SCENARIOS	73
4.1	Basin-wide Perspective.....	74

4.1.1	Five-Year Scenario (Year 2010).....	74
4.1.2	Twenty-Year Scenario (Year 2025; Assuming Best Practices)	76
4.2	Lao PDR Perspective	77
4.2.1	Five-Year (Year 2010) Scenario.....	77
4.2.2	Twenty-Year Scenario (Year 2025; Assuming Best Practices)	77
4.3	Local Perspective - NT2-HPP Proximal Impact Zones	78
4.3.1	Five-Year (Year 2010) Scenario.....	78
4.3.2	Twenty-Year Scenario (Year 2025; Assuming Best Practices)	78

LIST OF TABLES

Table 1:	MRC National Sub-areas	4
Table 2:	Estimated Evaporation plus Transpiration from Crop Plants (mm/day)and cropping areas in the Lower Mekong Catchments (km ²)	22
Table 3:	Influence of Static Head variation on Irrigation Pump Energy Consumption	28
Table 4:	Irrigated Dry Season Rice in the LMB and Predicted Increase (km ²).....	37
Table 5:	ADP Planned Irrigation Schemes in Khammuan Province	43
Table 6:	Existing Irrigated Land Potential Increase in the NT2 affected Catchments	44
Table 7:	Existing & Potential Increase of Irrigated Land in the Nakai Plateau and Nakai-Nam Theun NBCA	46

1. PART 1: GEOGRAPHY & LANDUSE MECHANISMS

1.1 Introduction

In terms of Basin hydrology, agriculture is both an impacting and impacted sector. Agriculture expands at the expense of forest. In the hills, expansion of agricultural area without investment in soil-erosion control precautions such as contour bunds or cover crops, leads to aggregated flood run-off, erosion and consequent sedimentation. In the wetlands, it leads to deterioration of fish spawning and feeding grounds. Agricultural intensification in response to increasing population density involves water harvesting and/or irrigation, which reduces downstream discharges through re-evaporating some of the captured rainfall or diverted stream water to the atmosphere. Irrigators themselves are impacted by upstream catchment deforestation and/or hydropower scheme operations. For almost a century, population growth and in-migration into the Basin has caused expansion of traditional agricultural practices into the upland and highland catchments on the one hand and into fragile wetland habitats on the other. This agricultural area expansion has been spontaneous and uncontrolled rather than planned and organised. Most of the riparian governments have attempted from time to time to promote organised rural settlement or resettlement; these have been largely unsuccessful as planning and budgeting have concentrated more on installation of community infrastructure than on investment in land development measures to support stable agriculture.

This Annex provides an overview of the past and present landuse situation in the catchments of the Mekong drainage basin. In particular, emphasis is placed on the impacts of agricultural landuse on the regosphere (the topsoil and subsoil clothing the bedrock), which supports the terrestrial food chain, and the hydrosphere (the water circulating through the atmosphere, the regosphere, deep aquifers, streams and other water bodies) this supports navigation, irrigation and the aquatic food chain.

Basin-wide, member governments are coming to recognise that sustainable economic prosperity will depend upon restoring and maintaining a functional balance between humankind, the environment and the ecosystems, together with restoring a measure of parity between the rich and the poor on the one hand, and the urban and the rural on the other. Emerging low-season programmes emphasise such aspects as poverty alleviation, forest and wildlife conservation, upgrading of health and education services, decentralisation, augmentation of rural infrastructure and so forth. The need for investment in soil-erosion control measure, however, does not yet seem to have been fully recognised.

The past two decades of technical and financial support to the member countries has brought about a considerable increase in the prosperity of the urban middle-classes, but this has sometimes been at the expense of the natural resources in the rural areas and the livelihoods of their populations rather than the reverse.

In this era of globalisation, with burgeoning populations competing for finite resources and economic opportunities, the prime aim of infrastructural and technological development should be to equitably enhance human welfare (health, strength, security, longevity) opportunities for both present and future generations, with an emphasis on making rural lifestyles more attractive and rewarding in order to halt the inefficient overcrowding of large cities.

When assessing the impacts (either direct or cumulative) related to infrastructural development on the livelihoods of the various impacting and impacted stakeholders, it is advisable also to assess the sustainability and the social and legal acceptability of the livelihood modalities of said stakeholders and to plan and programme the necessary corrective and restitutive measures. Thus it is not only the *installation* of

community infrastructures such as roads, hydropower schemes and irrigation systems that must be assessed, but also the impacts of their long-term *operation* and ultimately, their decommissioning.

Part 1 below describes the various geographic characteristics of the Mekong Basin and the various livelihood modalities and technologies employed by the rural inhabitants of the various parts of the Basin, together with the environmental (particularly hydrological) impacts thereof. Particular emphasis is given to a description of the various types of irrigated agriculture because of its propensity to support high population densities and thereby relieve the pressure of agriculture on forested lands and fragile habitats.

Part 2 describes Present and Short-term Landuse Trends with reference to various tracts and sub-tracts within the Basin having as commonality of present landuse modalities and/or future landuse management, investments and requirements for sustainable usufruct.

In Part 3, with sustainability and equitability in mind, "Best Practices" for the various processes involved in the planning and operation of water resources projects are described, together with best practices for landuse in their upstream and downstream impact zones. Implementing policy and institutional strengthening requirements are also discussed. Rather than accepting present trends (which may be unsustainable) as inevitable, the Best Practice approach studies the sustainable carrying capacity of the land and its soil for the various optional uses under the various technological modalities, which are or may become available keeping in mind demographic projections and economic and social preferences. This Annex also outlines the reorientation of ongoing landuse data gathering, analysis and processing that will be required in order to plan and actualise the "Best Practice" scenarios described.

Part 4 envisages the probable landuse situation, which could be expected in the various tracts of the Basin on the commissioning of the Nam Theun 2 Hydropower Scheme (around the year 2010). The 20-Year Scenario envisages what could be the situation if the policy, institutional and Best Practises recommended, are implemented Basin-wide.

The References listed in Part 5: Bibliography provide practical details of most of the Best Practices recommended except in the case of detailing the recommendations to the Mekong Basin Geo-referenced Management Information System. Said recommendations are still in preparation by EcoLao in consultation with the agencies involved.

1.2 Zonation of the Mekong Drainage Basin

1.2.1 Geographic Subdivisions

The Greater Mekong Sub-Region (GMS) is a term coined by the Asian Development Bank (ADB) for an economic development planning and investment zone, comprising the entirety of the Mekong Drainage Basin plus peripheral provinces in China, Cambodia, Lao PDR, Myanmar, Thailand and Vietnam. The Mekong Drainage Basin itself is split between the Upper Mekong Basin (UMB) located entirely in the People's Republic of China and the Lower Mekong Basin (LMB), incorporating the majority of Lao PDR and Cambodia, and parts of Thailand, Vietnam and Myanmar. River Gauging Stations have been installed at intervals along the mainstream and tributaries throughout both the UMB and LMB. They are identified by place name and by distance from the river source. The cumulative catchment area pertaining to each station has been listed.

The Upper Mekong Basin (UMB)

This area is divisible into three geographically distinct sub-areas, namely: the Tibetan Plateau Snowfields, the Gorges and Cataracts Reach, and the Sip-song Panna ("Twelve Thousand Rice-fields") Plain.

The Lower Mekong Basin (LMB)

In the LMB, the drainage network has been numerically coded with the Mekong mainstream being coded 101, the Bassac 301 and the Xe Bangfai 3201. Each major tributary sub-catchment has a code number with corresponding code numbers for the sub-tributaries, e.g., the Nam Kading tributary basin is coded as number 27, the Nam Kading mainstream is 2701 and the Nam Muan sub-tributary is 2703, etc. The distance in kilometres from the river source is registered for each major tributary confluence and each reach of the Mekong mainstream has been assigned a code number.

Utilising remote sensing with ground truthing, the MRC has classified the entirety of the LMB into five major Watershed Classes (WSC), based primarily on landforms:

- Watershed Class 1 - Areas with very steep slopes and rugged landforms
- Watershed Class 2 - Areas with steep slopes, usually at higher elevation
- Watershed Class 3 - Areas with moderate to steep slopes and less erosive landforms
- Watershed Class 4 - Gently sloping lands
- Watershed Class 5 - Gently sloping land and flat areas.

This may be termed "micro" landform classification.

At the macro level, the MRC has grouped similar climatic and geomorphological characteristics (i.e. similar mixes of the Watershed Classes) into nine sub-areas as per Table I - 1 below. The sub-areas of the LMB are grouped into four "regions", namely: A - Northern Highlands, B - Central Plateau and Highlands, C - Southeast Highlands and D - Southern Region.

Table 1: MRC National Sub-areas

Sub-area No.	Sub-area Name	Area (sq. km.)	Forested (sq. km.)	Rainfed Agriculture (sq. km.)	Present Irrigated Area (sq. km.)	Potential Irrigation Expansion (sq. km.)	Remarks
A: Northern Highlands							
1L (+1V)	Northern Laos	82,682*	72,098*	10,974	570	n/a	Includes 1,395 km ² of 1V
2T	Chiang Rai	17,333	†	2,529	1,500	300	
B: Central Plateau and Highlands							
3T (+3L)	Songkhram / Nong Khai	51,515	†	29,366	>6,000	n/a	Includes 9% in Lao PDR
4L (+4V)	Central Laos	82,614	66,651	9,977	1,150	n/a	Includes 733 km ² of 4V
5T	Mun Chi	119,122	†	83,331	18,777	n/a	
C: Southeast Highlands							
6L	Southern Laos	19,688	27,006 *	*	386	n/a	Includes 1,220 km ² of 6C. Forest & ag. data include 7L (?)
6C	Southern Laos	3,218	2,961 *	119	0	n/a	Not including the 1,220 km ² under 6L (?)
7C	Se San, Sre Pok, Se San	25,958	24,219	1,375	0	n/a	
7L	Se San, Sre Pok, Se San	21,491	*	*	*	n/a	Area by interpolation of data. Forest, Agricultural data probably with 6L (?)
7V	Se San, Sre Pok, Se San	30,384	16,499	3,439	860	n/a	
D: Southern Region							
8C (+8V)	Kratie	20,236*	18,496	1,060	33	58	May include 8V (?)
9C (+9T)	Tonle Sap	81,679*	54,969	19,042	403	1,140	May include 9T (?)
10C	Delta	25,307	9,304	13,235	734	1,287	
10V	Delta	34,210	1,283	0	28,734	n/a	

Predominant Geomorphology

SA1 - 85% mountainous with mainly narrow valleys. SA2 - extensive lowlands rimmed with cultivated hills. SA3 - flat to rolling plains, interspersed with flood reticulation wetlands. SA4 - flat to rolling plains, steepening to hills and the Annamite Mountains in the east; interspersed with flood reticulation wetlands and karst outcrops. SA5 - Flat to rolling cultivated plains; good soils in the west, becoming poorer in structure and fertility with easting; some salinity. SA6 - mountain plateaux and cultivated foot-slopes, predominantly good soils. SA7 - rolling to hilly plateau soils of good fertility. SA8 - flat to rolling cultivated hills, steepening to mountain forests in the east. SA9 - large areas of flat to rolling farmlands, seasonally inundated near the lake and watercourses, bounded by the Cardamom Mountains in the south and the Khorat Plateau escarpment in the north. SA10 - seasonally flooded flatlands, tidally influenced towards the south.

Source: MRC Data set.

*: Conflicting data

†: No information

1.2.2 *Administrative Sub-divisions*

Available maps for the Basin delineate national, provincial district and municipal boundaries. In Thailand, administrative boundary mapping goes down to *Tambon* "sub-district or commune" level. In Lao PDR, it can vary, however, largely due to communalisation under previous regimes. Village territorial boundaries are only now being delineated (in Lao PDR, under the Land and Forest Zonation and Allocation Programme) and there remain numerous inter-village territorial overlaps to be resolved. In some cases (such as on the western escarpment of the Nakai Plateau), uncertainties regarding village territorial boundaries extend to district territorial boundaries, especially when unlogged forestland is involved.

MRC mapping depicts the point location of such features as villages and irrigation system headworks, while the accompanying databases provide information on population estimates and village names, type of irrigation project, etc. and even rough estimates of population density, also irrigated hectareage of farmlands. Without village boundary delineation, however, population density per unit area of cultivable farmland cannot be calculated and this is an essential tool for prioritised integrated rural development and management planning.

Similarly, it is not at this time possible to relate various irrigation projects to the territories of the villages that operate them. Two mainstays of the MRC Basin Development Planning campaign will be the elaboration of the Decision Support Framework (DSF) and Resource Allocation Optimisation Model (RAOM). In the long-term, the modality and sustainability of rural landuse, particularly in reservoir catchments, will have significant influence upon downstream basin hydrology and sedimentation. This has been dramatically illustrated by the case of the Manwan Hydropower Project in southwest China, where under-planned and under-funded resettlement into the catchments, with insufficient integration of agriculture and forestry has led to catastrophic erosion and landsliding. The resulting sedimentation has reduced the planned lifespan of the hydropower scheme to 30% of the original estimate. Long-term planning for environmentally sustainable settlement and rural landuse in strategic river catchments requires both land capability assessment and demographic projection, referenced to the territorial extent of each present and planned rural village.

A next important step in MRC's Basin Development Planning campaign, therefore, would be to follow the lead of European and Scandinavian countries by defining and mapping Basic Statistical Units (BSUs): city blocks, suburbs and rural village territorial boundaries as zones of reference for statistical recording, development planning and management-oriented monitoring. This augmentary mapping can be performed using stereoscopic interpretation of the most recently available aerial photographs supported by ground-truthing, involving the participation of local government officials and the elders of neighbouring villages.

1.2.3 *Climatic Zonation*

The climatic regime of any particular landscape (in terms of temperature, rainfall, humidity, wind-run, sunshine hours, etc.) helps determine, not only what the various soil types clothing the various landforms in that landscape will produce in the form of subsistence and economic commodities, but also how much, where and when run-off and stream-flow will emanate from that landscape. The following Koppens Climatic Zones are applicable to the Lower Mekong Basin:

- Aw - Tropical Wet-Dry - Savannah
 - all average monthly temperatures greater than 18°C

- more than 2 months have less than 6cm precipitation; distinct dry season during low sun season (winter);
- distinct wet season high sun season (summer);
- Cwa - Humid Subtropical - Warm with distinctly dry Winter
 - average temperature of warmest month averages over 22°C
 - average temperature of coldest month is under 18°C and above 3°C
 - winter drought; at least 10 times as much precipitation during wettest summer month as in driest winter month.

1.2.4 *Ecological Landscapes & Ecoregions*

It may be said that the one certainty in life is the constancy of change! The temperature of Planet Earth and the temperature and humidity of its atmosphere have been fluctuating for millions of years. It is the rapidity of such fluctuation that determines the integrity of the ecosystems supporting the food chains. The more species that co-exist in an ecosystem, and the more the genetic variation, the more likely it is that the food chain will remain productive. Humankind is one of, if not the only, form of life that can plan for and actively influence future scenarios through technologisation. Most animals are protective of their offspring in the immediate present, but only humankind exhibits communicable concerns for the welfare of future generations. In the absence of definitive data on very complex environmental and ecological parameters and their interactions, the Precautionary Principle dictates that a viable proportion of each landscape or sub-area be reserved and protected under pristine natural vegetation as inter-connected biogenetic reserves, facilitating adaptation of components of the food chain to climatic changes.

The World Wildlife Fund (WWF) has classified ecoregions as "*relatively large units of land or water containing a distinct assemblage of natural communities and species, with boundaries that approximate the original extent of natural communities prior to major land-use change*" (WWF, 2004). The WWF has delineated the following ecoregions in the LMB:

Code	Ecoregion
IM0106	Cardamom Mountains Rain Forests
IM0121	Luang Prabang Montane Rain Forests
IM0136	Northern Annamites Rain Forests
IM0137	Northern Indochina Subtropical Forests
IM0138	Northern Khorat Plateau Moist Deciduous Forests
IM0139	Northern Thailand-Laos Moist Deciduous Forests
IM0152	Southern Annamites Montane Rain Forests
IM0164	Tonle Sap Freshwater Swamp Forests
IM0165	Tonle Sap-Mekong Peat Swamp Forests
IM0202	Central Indochina Dry Forests
IM0210	Southeastern Indochina Dry Evergreen Forests
IM0211	Southern Vietnam Lowland Dry Forests

1.2.5 *Future Landuse Zonation*

This accumulative impact assessment report propounds a qualitative prediction of the situation that could prevail in the Nam Theun 2 Hydropower Project (NT2-HPP) wider impact zone by the year 2025. The available data is not yet sufficiently complete or

organised to permit of a quantitative prediction at this time. The necessary tools and instruments are available however, in the form of aerial photographs, satellite imagery-based maps, meteorological and hydrometric stations, trained socio-economic enumerators and GIS technicians.

Ideally, the prime outputs of the MRC's Basin development planning programme should be a Visionary Landuse Zonation Scenario mapped for each province throughout the entire basin, founded on land capability assessment, combined with demographic projection and socio-economic titling. In cases such as the NT2-HPP, where trans-basin diversions are involved, and/or several private sector or joint-venture entities may in the future be operating water resources and schemes on the same river system (which may also involve one or more adjacent provinces), then the planning module for Visionary Landuse Zonation should incorporate the entirety of all provinces concerned .

In Lao PDR, the Visionary Landuse Planning process has been piloted in connection with resettlement planning for several hydropower projects and in project preparation for the Project for Poverty Alleviation, Land Use Stabilization and Environmental Protection in the Upper Nam Ha Watershed, Northern Economic Highway Corridor (ADB Route 3) (ADRA, 2003).

For example, the Visionary Landuse Zonation map for a typical province in the MRC Area 'A', Northern Highlands, would delineate the year 2025 zonation scenario agreed by representative stakeholders (villagers, local and central government, businesspersons, traders, police, military, etc.) for devotion to the following categories of landuse:

- transportation corridors,
- urban areas (including residential, commercial, administrative, industrial, recreational),
- irrigated agriculture,
- other agriculture,
- tree plantation,
- production forestry,
- watershed protection,
- nature conservation.

Quantification of the developmental and management inputs required to achieve this visionary situation would provide a necessary framework for informed political and investment decisions for the achievement of their environmentally sustainable and socially equitable future.

1.1 Rural Landuse and Livelihood Regimes

Each class of land throughout the Mekong Basin is devoted to one or other landuse regimes; each rural family derives its livelihood from one or other or a combination of several said regimes. Each of the regimes can be sustainable only up to a certain level of population density combined with the relevant management safeguards (e.g. to prevent soil erosion or biodiversity decimation). For instance, a villager residing in a highland valley may fish in the river, have an orchard on the levee, grow rice in the back-swamp paddy fields and burn the nearby hillsides to grow cassava or maize to supplement his rice and also hunt and gather wild animals and non-timber forest products in the surrounding mountains. Each type of landuse has an impact on the atmosphere, the hydrosphere, the regosphere, the biosphere and the local and regional socio-economies. Impacts may be positive, e.g. carbon sequestration or negative, e.g. soil erosion. In accordance with their geographical location in relation to

water resources exploitation infrastructures, rural land-users may be either impactors, e.g. cultivators in the catchments, or impactees, e.g. downstream irrigators.

Sipsong Panna region of southwest China, together with the Lower Mekong Basin experience three distinct climatic seasons annually: the hot-wet season (May/June through September/ October; the cool, dry season (November through January) and the hot-dry season (February through April). In rainfed upland and highland farms, the wet season is the main season for cultivation of crops, primarily maize, cassava and upland rice (often mixed with vegetables, pulses, peanuts). Crops such as mung bean and the opium poppy may be cultivated through the cool-dry season, surviving on residual soil moisture.

Any particular parcel of land has numerous optional future uses. These range from urban development through industrial development (including mining or reservoir construction), various types of agriculture, plantation, forestry or nature conservation. The rights of access to and management of, the said parcel of land may be designated as private, communal, corporate or governmental. For a particular land parcel, the ultimate measure of landuse sustainability is the maintenance of the integrity of the topsoil, which supports the vegetation, providing foodstuffs, fodder or other commodities for the use of humankind. Provided the topsoil remains in place and its organic matter content is preserved, then any current landuse (e.g. agriculture), can be converted to any other socially or economically desired future landuse (e.g. forest plantation), by implementing the land management measures required to replace one form of vegetation with another. This is not however possible if the topsoil has been eroded or degraded except by invoking (expensive and complex) rehabilitation measures. If topsoil integrity is maintained by sustainable landuse, even the restoration of the natural (pre-human intervention) ecosystem can be achieved, provided that, at the landscape level, a certain proportion (at least ten percent) of the area has been preserved as a biogenetic "reservoir".

Man can do little to control the weather, but he can increase the productivity, or extend the growing season, of the crops on his land by providing artificial rainfall in the form of irrigation. As today's growing population, with its growing economic aspirations, calls for more and more productivity from each unit area of land, then the optimisation of irrigation system efficiency and extent takes on increasing importance. There are trade-offs that planners must keep in mind however:

- maintenance of dry season stream flow requires protection of the stream catchments, i.e. fibre or fruit-tree cropping rather than staple food arable cropping.
- expansion of agriculture into drained wetlands is generally at the expense of fish spawning grounds.

The following is a review of the rural landuse and livelihood regimes found in one or other part of the Mekong Basin. It is interesting to note that ancient and modern practices still co-exist side by side.

1.2.6 *Hunting & Gathering*

Thousands of years ago, the entire Mekong Basin was populated by hunting/gathering/fishing communities who travelled from site to site to enable depleted wildlife populations to recover their numbers before returning some months or years later to hunt and gather again.

Even today, small bands of semi-nomadic hunter-gatherers still roam parts of the Lao-Thai and Lao-Vietnam border areas. Bands of hunter-gatherers operate within a large, loosely defined territory, whose boundaries may, from time to time, be agreed or contested as the case may be, with other clans or tribes. Individuals have an equal

right to hunt or gather in their tribal territory and specialisation is at a minimum since virtually the full time of every family member is occupied in the pursuit of foodstuffs.

Hunting and gathering is a sustainable form of existence but only if overall population does not rise above a density of two persons per square kilometre. The hunter-gatherer communities inhabiting those parts of rural Lao PDR where population (i.e. resident plus transient) remains below this level have very little money but must not necessarily be considered to live in a state of livelihood poverty. Given the warm, moist climate, further modulated against extremes by the tall forest habitat, clothing and shelter needs are minimal and the jungles provide all the materials required for hunting and for making the simple tools and equipment needed for hunting and fishing.

The rivers and forests also fill a very wide range of dietary and medicinal needs, and if a shortage occurs on one tract of land, the bands merely migrate to another. Parents and tribal elders provide the children with all the education (experiential plus theoretical) required for them to maintain their livelihoods through succeeding generations. Economic prosperity has little meaning to these communities, as accumulated wealth and possessions become burdensome to transport from hunting ground to hunting ground. Because of the need to maintain low population densities to ensure survival, semi-nomadic hunter-gatherer societies have evolved several techniques for ensuring that surviving children are no closer than 4-years apart (taboos, abstinence, prolonged lactation, abortion, herbal contraception, infanticide, etc.). Environmental and ecological impacts are zero. Poverty is exhibited only in the case where childless couples become aged and infirm and have no close family to care for them.

Having no farms however and little time available away from food gathering to allow them to assemble protective militia, these communities are highly vulnerable to armed bands of hunter-gatherers from other areas, or from those who would fell the forests for lumber or for farming. In Lao PDR, only pro-active land-use zonation can preserve their social and economic integrity.

Apart from game, fish and edible shoots (including rattan and bamboo), staple foods for hunter-gatherers include sago and wild yams. Modern day hunter-gatherers supplement their diet staples with rice, which is traded for non-timber forest products.

1.2.7 *Agriculture*

Shifting cultivation provides a means of producing foodstuffs for subsistence on steep and rugged terrain, unsuited to permanent cultivation. It is sustainable, however, only at low population densities and it persists at the expense of timber production. Smallholder-based mixed farming is the most productive in terms of overall yield of consumable product, but presents problems in ensuring the uniformity of quality demanded by the urban and export markets. Large-scale commercial operations based on monoculture can be more easily geared to meet consumer demand but can lead to disparities between workers and owners and can lead to problems with chemical pollution and biodiversity degradation.

Pioneer Shifting Cultivation

The pioneer swiddeners who populated the highlands above 800 metres altitude, bringing with them the axe, the crossbow and the opium poppy, which is at once a food (poppy seed), a medicine (anti-spasmodic) and a narcotic (smoked directly, or smoked or injected as a derivative, heroin or morphine). The main pioneer cultivating groups are the Hmong, the Yao and the Akha; the most sophisticated, literate and monetised being the Yao and the Hmong. They were all originally paddy-cultivating groups in South-west China but were pushed uphill by continuous armed Chinese invasions.

Pioneer cultivators eliminate all trees and seed sources unlike the cyclic re-occupance cultivators who lop and retain tall trees as a seed source for bush fallow regeneration. When the successively cultivated pioneer swiddens are finally abandoned due to soil erosion and fertility decline, they are populated by weed grasses, particularly the fire-tolerant *Imperata cylindrica*, which is unpalatable to livestock except during its very early growth stages. Accordingly, these fields are burnt annually by graziers, effectively suppressing forest regeneration. Run-off from grassland is twice as high as for old-growth forest and evapotranspiration less than half - so aquifer recharge is also repressed due to the absence of tree root channels penetrating the bedrock. Absence of tree roots also aggravates incidence of landslides, a source of severe sediment loading in tributaries and the main stream. When grasslands are burnt late in the dry season the opening rains may cause even further topsoil erosion.

Cyclic Re-occupance Shifting Cultivation

The cyclic re-occupance shifting cultivators who populate the uplands and foothills, usually below 700-800 metres altitude, include many Tibeto-Burman, Mon Khmer and Vietic groups such as the Karen, the Khmu, etc.

The predominant livelihood system for the majority of the rural population in the uplands and highlands of the LMB is slash and burn shifting cultivation (swidden agriculture; a form of extensive agro-forestry), supplemented by the gathering of Non-Timber Forest Products (NTFPs), hunting and fishing. Under a typical swidden cultivation regime, a family would cut/slash between 1.5 - 2 hectares of secondary forest at the end of the cool-dry season in early February. The felled material is allowed to dry for several weeks during the hot dry season and is burnt in April / May before the rains start. When the rains commence, seeds of upland rice are planted in holes punched into the ash-covered topsoil using sharpened sticks. Seeds of other crops (vegetables, cotton, hemp, sorghum, spices, etc.) are inter-sown with the upland rice. The swidden fields, which are usually on steep hillsides, are weeded throughout the rainy season and the crops harvested at the beginning of the dry season in late October or November.

After one season of cropping, the plant nutrients in the top soil become depleted. Hence, the farmers allow the cleared fields to regenerate to secondary forest (bush fallow) in order to restore fertility of the top soil and suppress weed re-growth. The deep roots of the regenerating trees in the bush fallow draw nutrients from the sub-soil (beyond the reach of crop plant roots). These nutrients are then deposited on the top soil through leaf fall and from the ash resulting from the next cutting and burning event. Full restoration of soil fertility will not be achieved unless the bush fallow interval between each cropping phase is at least 7 years (on the best soils) and in other cases up to 12 or even 15 years. Hence a typical family engaged in cyclic re-occupance shifting cultivation will clear and cultivate between 1.5 - 2 hectares per year but retain traditional use rights over 10-20 hectares of associated bush fallows at various stages of regeneration.

In addition to the foodstuffs grown on the cropped fields, other wild foodstuffs (both plant and animal), raw materials for building and handicrafts, other NTFPs and fuelwood may be garnered from the bush fallows and from the adjacent old growth forests. This cyclic re-occupance swidden farming system can support population densities of between 20 persons per km² (on the best soils) and 15 per km² or less otherwise. Traditionally under this situation approximately 50% of each village territory remains under primary forest which is preserved as a sustainable source of building timber and as a food security reserve in the event of crop failure (source of edible tubers, roots, shoots, leaves, fruits and wild animals).

Under mounting population pressure, however, shifting cultivation is not a system of agro-forestry remaining viable in the long term and has a significant opportunity cost with a poverty aggravating impact as follows:

When population densities grow in excess of 15-20 persons per km², a vicious cycle of increasing poverty emerges. Continuing population growth within circumscribed village territories leads to expansion of shifting cultivation at the expense of primary / old growth forest.

This progressive loss of primary forest diminishes the food security reserve, damages watershed integrity and reduces atmospheric carbon sequestration.

Loss of old growth forest habitat degrades local bio-diversity and consequently reduces eco-tourism value, inter alia.

To expand swidden areas between \$10,000-\$20,000 per hectare worth of standing timber from primary forest may be cut and burnt to fertilize a family's upland rice field that produces at best 2 tons of rice (worth \$600) per hectare once every 10 year cycle; this equates to an average of \$30/hectare/year. By comparison, in the same 10-year period, the incremental timber growth of tall forest would amount to 20m³/hectare (2m³/hectare/year) worth \$3000/hectare or \$300/hectare/year.

When the primary forest area within a village territory has been largely cut and brought into the shifting cultivation cycle, then, under continued population growth, rotational bush fallow cycles have to be shortened, resulting in declining soil fertility recovery between re-use and hence subsequent lower crop yield and productivity.

The average family labour availability is sufficient to clear, plant and weed only about 2 hectares in any one year. With lowered crop yields per unit area and therefore lowered farm productivity, coupled with family labour constraint, the population becomes trapped into a vicious poverty spiral.

Rural communities facing such a situation will remain so trapped in an increasing poverty spiral unless there is intervention to develop alternative livelihoods based on agro-forestry systems that are sedentarised and of higher productivity per unit area and per unit of labour input.

Sedentary Farming

Most of the ethnic groups in the uplands and highlands of Southwest China have learnt how to construct contours and terraces, but this is not generally the case in the hills of Myanmar, North Thailand or Lao PDR. Instead, swidden fallow cycles become too short and weed-infestation prohibitive, the dry season is spent in hoeing the topsoil deeply to kill weeds and oxidise some of the plant nutrients in the upturned subsoil to render them available to the roots of the subsequent crop. The ultimate result is severe erosion and eventual abandonment of the whole area to the regrowth of unproductive grasses and scrub, subject to annual burning, and requiring centuries rather than generations to recover productive capacity for agriculture or forestry.

After irrigation system upgrading it is the contouring and terracing of cultivated hillsides that requires the most urgent attention in the form of technical and financial support.

Rainfed Arable Farming

Under this system, annual crops are planted every year without a respite under bush fallow, manures and fertilisers may be applied to maintain fertility. This agricultural practice may be sustainable on slopes up to 25%, provided that soil erosion control measures (e.g. contour bunds, terraces) have been installed on slopes between 5% and 25%. The main arable crops grown on sedentary rainfed farmlands in China, Myanmar and north Thailand are upland rice, maize, mung bean, soybean and peanuts. Since the 1960s, in northeast Thailand and southern Lao PDR, cassava,

sesame, sorghum, kenaf and sugarcane have been cultivated from time to time in response to the vagaries of demand from local and export industries. The expansion and diversification of commercial agriculture was triggered mainly by the expansion and upgrading of the road network in northeast Thailand. As oil prices continue to rise, it could be expected that the better quality arable soils in Thailand, southern Lao PDR and upland Cambodia sectors of the Basin would be devoted to sugarcane production, extracting ethanol for motor fuel from the juice and burning the bagasse for steam turbine electricity generation.

Irrigated Farming

Whereas hunting and gathering can sustainably support only two persons per square kilometre, irrigated agriculture on good soils with reliable water supply and sophisticated water distribution and drainage network can support up to two thousand. Compared to swidden cultivation, the sustainable population density supportable by rice-farming regimes irrigated by rainfall capture rises to between 50 and 100 persons per square kilometre. Exportable surpluses of cattle and buffalo and dry season off-farm labour become available to support urban construction or military purposes. When secondary forest is converted to hand-cultivated paddy field there is a decrease in overall annual evapotranspiration (because dry season stubbles do not transpire) and a consequent increase in aquifer recharge, although (especially if stubbles are not burnt) there is a reduction in emission of carbon dioxide, a greenhouse gas. This may be replaced, however, by the emission of methane from rotting vegetation in the ponded water. Methane has four times the heat-insulating properties of carbon dioxide. Irrigation systems are described in detail in Section 1.4 and subsequently.

Wetland Farming

Particularly in rain shadow tracts, agriculturalists have cleared the flood forests from the edges of flood reticulation wetlands (including parts of the Tonle Sap Lake shores) for the cultivation of floating rice in the wet season and/or recession rice in the cool dry season as flood levels recede. In some cases, such as in the Lower Xe Bangfai Basin, in parts of the Mekong Delta and in Cambodia, flood control and irrigation infrastructures such as levees, canals, gates or pumps have been installed to enable the production of three rice crops per annum.

1.2.8 *Animal Husbandry*

Domesticated livestock of one type or another are an integral component of smallholder agriculture Basin-wide; even the semi-nomads keep dogs for hunting. In remote rural areas, the relationship between the cause and effect of livestock diseases is not generally understood and both sanitation and health are poor. Thailand and Vietnam have the most progressive veterinary services.

Large Livestock

In the Mekong Basin, elephants, horses, cattle and buffalo have been domesticated for centuries. Elephants have been used mainly for warfare and logging, while horses are used as pack animals, particularly in mountainous areas. Apart from their use for draught, for rice cultivation and transportation, cattle and buffalo also serve as "walking savings banks". In the pre-chemical fertiliser era, they played a key role in maintaining rice field fertility - freely manuring the ground whilst grazing the stubbles in the dry season and through the accumulation of dung deposited at their night camps whilst grazing in the fields and forests during the wet season. As a rule, as population density increases, large livestock may be stall-fed on forages grown in irrigated fields and cut-and-carried to the stalls, where their dung is composted for manuring the fields. Most farm families strive to keep some large livestock but only near the larger urban areas do farmers specialise in intensive large livestock production, in beef feedlots, dairy farms, etc. Except near urban centres, buffalo or cattle are not milked.

On the Nakai Plateau (in the proposed NT2-HPP area) most of the families at Ban Bor Cho are on the military payroll. Their duty is to tend large herds of buffaloes, which are raised to provision the military, or for sale to contribute to army operating revenues. Some families in the other twenty or so riverside villages on the Nakai Plateau also raise buffalo. Some of these are family-owned, others are on loan or agistment from farmers on the Nyommalat Plain who grow dry season rice in their paddy fields, and have no alternative land for grazing their buffaloes.

Small Livestock

Small livestock husbandry throughout the Basin emphasises pigs and poultry, traditionally fed on rice bran and otherwise allowed to range freely around the villages. More recent introductions include goats, rabbits and some hamsters. In and around large urban centres, specialists raise pigs and chickens in intensive battery-cage feedlots. The risk of epidemic diseases transferring from animals to humans is becoming of increasing concern in these cases.

1.2.9 *Forestry and Tree Plantations*

Exploitive Logging

The timber harvestable from one hectare of mature, pristine forest may be worth as much as US \$20,000 at today's prices. Historically, in Southeast Asian countries, the derivation of income from timber sales has been the prerogative of the ruling elites. For almost two centuries, the exploitation of logs from the Mekong Basin has been facilitated by foreign-based companies. The British Borneo Company and the East Asiatic Company extracted teak logs from eastern Myanmar and northern Thailand. Up to the early 1950s, a French company (Compagnie Asiatique et Africaine) was extracting teak logs from Xainyabuly in Lao PDR and floating them down the Mekong for export through Saigon Port.

In Thailand and Vietnam, virtually no primary production forests remain, while sawmilling by both sides in the recent Cambodian conflict has degraded large tracts of forest in that country. Normally, when forests are logged they will regenerate, but rapidly growing rural populations, plus the fact that rural communities have previously had no legal rights to timber, has caused them to convert logged-over forest to shifting cultivation or permanent agriculture. In 1980, China embarked upon a reforestation campaign experimenting with many different models of State, State-owned, community-owned and privately owned forests. In Lao PDR, much of the potential cash value of timber from exploitively harvested logs is lost due to inefficiencies in transportation, storage, processing and marketing.

In the late 1980s, the upgrading of National Highway Route 8B opened up the Nakai Plateau for logging with timber processing facilities being established at Nakai, Mahaxay and Thakhek. Timber was trucked out in both directions, to Vietnam through Lak Xao and to Thailand through Thakhek. Branch roads were poorly maintained, and wear and tear on logging trucks very high, timber wastage was high due to inefficient forwarding practices. Very little timber revenue accrued to either local government or to the local communities. Low salary scales for civil servants has forced local government personnel to engage in income supplementary "rent seeking" rather than in the efficient execution of laws and regulations concerning the protection of the environment and ecosystem. Neither have they had the motivation, capacity or assets to effectively deliver governmental services in the fields of health, education, etc.

Sustained Yield Production Forestry

The yield of timber from production forests may be sustained indefinitely if the appropriate silvicultural management practices are applied. These involve the removal of timber at no greater than its regeneration rate and the minimisation of gaps in the

leaf canopy to ensure that re-growing trees are of good shape. Other silvicultural measures to be applied include fire protection, weeding, thinning and pruning. Logging roads are pre-surveyed, pre-constructed and protected from erosion. Mother seed trees are retained, rather than felled for sale.

With the involvement of the World Bank (Sustainable Forestry Rural Development Project [SUFORD]) and some conservation NGOs (e.g. The Forest Stewardship Council and the Tropical Timber Trust), sustainable forestry methods are being introduced into Lao PDR and Cambodia, in collaboration and shareholding with the local rural communities.

Industrial Tree Plantations

Worldwide demand for wood fibre (for paper pulp, building, etc.) continues to expand, especially since China has closed down paper production from its own resources in order to allow regeneration of deforested hillsides. In northeast Thailand, lands of inherent low soil fertility or lands depleted by exploitive cassava cultivation have been replanted to fast-growing industrial tree crops, such as *Eucalyptus* and *Acacia*. A similar landuse regime was also introduced into Lao PDR by both the private sector and the Asian Development Bank (ADB) Industrial Tree Crops Loan Project, with provisions for the incorporation of smallholders into the industry. Rubber plantations are being grown along the Mekong Valley in China, northern Lao PDR and Thailand. Further promotion of smallholder industrial tree crops plantation has great potential for the conversion of hilly lands from shifting cultivation to uses that are more productive. Other industrial species of interest include eaglewood, bamboo, benzoin, dammar and cinnamon.

Farm Forestry

A potential poverty alleviation measure for the residents of hilly catchment areas is the introduction of legalised income from forestry into the farm-family income-stream. This strategy has been incorporated into the Resettlement Action Plan (RAP) for NT2-HPP and in the planning for the project for the *Project for Poverty Alleviation, Land Use Stabilization and Environmental Protection in the Upper Nam Ha Watershed, Northern Economic Highway Corridor (ADB Route 3) (ADRA 2003)*.

1.2 Impacts of Landuse on Basin Hydrology

1.2.1 Categorisation of Impacts

Pre-Project or "Background" Impacts

Any anthropogenic intervention in the natural ecosystems causes an "impact", which may be positive or negative, usually the latter, on the atmospheric, hydrospheric and regospheric components of the environment. These, in turn, impact upon the natural food chain, which has eventual implications for the survival of the various species in the natural ecosystem and thereby upon human livelihoods.

Even before any hydropower project intervention in the Mekong Basin, the mobile and rapidly growing rural population has already been causing adverse impacts on the ecosystem, the hydrology, etc., through unsustainable landuse practices.

Well before civil works construction commenced, external factors, including warfare, logging, population increase, migration due to land degradation elsewhere and highway construction were severely impacting the environment and the biodiversity as well as the poor communities themselves in the catchments of the Nam Ngum and Theun-Hinboun schemes and on the Boloven Plateau in Lao PDR and in the Vietnam Central Highlands catchments of the Xe San and the Sre Pok. In the case of the Theun-Hinboun Hydropower Project for example, the existence of these background impacts implies that the direct impact compensation efforts of the THPC, when

completed, will leave the directly impacted communities slightly better off than the pre-project situation, but still perilously close to the poverty line and still pursuing environmentally and ecologically hazardous shifting cultivation, forest degradation and wildlife poaching.

Most of the rural families throughout the catchment are in the same situation because hydropower developers cannot be reasonably expected to redress all landuse and environmental problems that were extant before their advent on the scene; some of these issues (health, education, wildlife management) are being addressed in the catchments upstream of the proposed Nam Theun 2 Reservoir by governmental rural development projects supported by World Bank and the Government of Japan.

The issues of rainfed land development, soil conservation and forest rehabilitation are still to be addressed however. Truly relevant environmental and social impact analyses therefore should address the impact of historical as well as expected future conditions. The environmental and social mitigation action plan should provide for an equitable attribution of mitigatory interventions and their financing between the project developer and the host government (presumably financed by start-up grants or loans from international development donors/lenders). Even without the intervention of hydropower projects, the "background" residual effects of warfare (UXOs, displacement of communities, etc.), exploitive logging, narcotics production and trade, and other unsustainable landuse practices of the indigenous communities are identified as needing remediation under the Lao PDR Government's National Environmental, Social And Poverty Alleviation Action Plans.

Direct or Project-specific Impacts

If the impacting intervention concerned is the construction of a reservoir storage hydropower scheme, the impacts will be felt upstream (better access but increased landuse pressure on the catchment), downstream (improved irrigation water supply but impaired water quality); down wind (reduced smoke emissions but increased atmospheric water vapour and methane) and down-line (cheaper and more plentiful electric power).

"Added" Impacts

In the case of the NT2-HPP, added impacts can be defined as the impacts that other and/or foreseeable hydropower developments may have on the NT2-HPP specific impacts and upon the pre-project background impacts in the vicinity.

"Induced" Impacts

These are the effects - social, economic, environmental or ecological - within the Basin that may be brought about by developments in other sectors, that could be induced by the construction and operation of the NT2-HPP, and which would not be expected to occur if the NT2-HPP were not constructed.

"Regional" or "Trans-boundary Impacts"

The NT2-HPP direct impact zone abuts Vietnam to the east and Thailand to the west, whilst downstream impacts extend into Cambodia and the Mekong Delta in South Vietnam. To the East, growing concern for the integrity of the catchment of the NT2-HPP and other hydropower projects in the Theun-Kading Basin will eventually constrain the current access to resources in Lao PDR enjoyed by both traders and rural communities from the Vietnamese side of the border. To the West, apart from enhanced availability of electricity, alteration of the Mekong mainstream river level and sedimentation regimes will have a slight impact on irrigators farming near the mainstream and around the flood-protection reticulation wetlands on the Thai side of the Mekong River. In the Cambodian wetlands and the Mekong Delta these effects will

be somewhat masked by the wet season rainfall regimes of Northeast Thailand and Central Lao PDR and by their dry season irrigation regimes.

1.2.2 *Impactors*

The main impactors on hydropower or irrigation schemes are those who reside in or utilise the catchments upstream of reservoirs or irrigation headworks. Negative impactors are those who misuse land in the catchments, leading to water pollution (which depresses the reservoir fish catch) or to erosion, which causes sedimentation that progressively reduces the active storage capacity of the reservoir and ultimately useful life of the generating facilities, culminating in decommissioning.

In the pre-project ("background") situation, forest type (particularly in China, Lao PDR and the Vietnam Highlands), forest-cover degrading agricultural landuse practices are exacerbating erosion and consequent sedimentation which leads to aggradation of the Mekong mainstream and tributaries. This adversely impacts the fishery, increases the risk of flood-damage and impedes navigation. When new hydropower or irrigation scheme diversions and storage reservoirs are constructed, the rate of downstream aggradation will diminish due to the trapping of sediment in the reservoirs behind the dams. When the dams are ultimately de-commissioned by dismantling or sluicing, extremely high rates of sedimentation and downstream aggradation could be expected until the sediment-filled ex-reservoir basins once again stabilise.

Positive impactors are those in the catchment who install soil conservation measures in the farmlands or regenerate forests on the steep areas, or who effectively manage wildlife conservation habitats and production forests. Any expansion of bunded paddy field irrigation would be expected to reduce the rate of sedimentation through trapping in the paddy fields sediments emanating from the surrounding foothills and slopes.

1.2.10 *Impactees*

Potentially positively affected impactees of hydropower project construction and operation include the following:

- Those whose cash wage employment opportunities become enhanced.
- Those who benefit from electric power supply.
- Those whose irrigation water supplies are augmented by power station discharges.
- Those living in areas where transportation facilities are enhanced by hydropower scheme access roads and reservoirs.
- Those living in areas developed for resettlement of reservoir oustees, whose road access, health, education and other facilities, as well as irrigation systems, are enhanced as a result of the facilities installed for the resettlers.
- Those whose business or trading livelihoods become enhanced as a result of increased economic activity in the vicinity of construction camps and power station operator's camps.
- Those whose fishing opportunities become enhanced by the filling of hydropower reservoirs.
- Those in downstream flood-prone areas, where the incidence of flood-damage will be reduced due to the retention of run-off in hydropower reservoirs.
- Those living in salinity-affected delta areas, where increased dry season stream flow from hydropower generation will reduce the intrusion of saline tidal waters.

Those who would be potentially positively impacted by the construction, expansion or upgrading of irrigation schemes would include:

- Those whose agricultural cropping seasons are extended by the availability of irrigation water.
- Those in surrounding areas having rice-deficits, thus benefiting from easier access to low-cost rice supplies.
- Those whose business or trading livelihoods become enhanced as a result of increased economic activity in the vicinity of the irrigated farmlands.
- Those in downstream flood-prone areas, where the incidence of flood-damage will be somewhat reduced by the routing of rainfall through bunded paddy fields.

Potentially, positively impactees of landuse stabilisation, land development and rehabilitation measures in the hilly and mountainous catchments will include:

- The local, regional and international present-day and trans-generational communities, who will benefit from improved air quality and carbon-sequestration attendant on reforestation and from the stabilisation of the food chain through the conservation of biodiversity.
- Hydropower and irrigation scheme operators, who benefit from the increased longevity of their schemes attendant upon their reduced rate of sedimentation, brought about by watershed protection.
- Timber users and processors who will benefit from reliable and durable supply from sustainably managed forests.
- Those in downstream flood-prone areas, where the incidence of flood-damage will be reduced due to increased retention of incident rainfall in the soils and aquifers in the catchments.
- Those living in salinity-affected delta areas, where enhanced dry season stream flow from forested catchments will reduce the intrusion of saline tidal waters.

Those who could be potentially negatively impacted by the construction and operation of hydropower projects and for whom the appropriate compensation and restitution measures should be incorporated in planning, would include:

- Those whose residences, business premises or farmland are to be occupied by hydropower scheme facilities.
- Those whose livelihood would be impaired by increased competition for resources from oustees in the event that the needs of the latter were not sufficiently catered for by restitution measures.
- Upstream fishing communities affected by the impediment to migration of fish species inherent in damming the river.
- Downstream fishing communities, where the poor quality of turbinated water and alteration of natural stream flow regimes may lead to depression of traditional fish catches.
- Irrigators downstream of trans-basin diversions, where flooding may be exacerbated by power station discharges.
- Potentially negatively-affected impactees of irrigation scheme construction, expansion or upgrading would include:
 - Those whose residences, business premises or farmland would need to be relinquished to make way for irrigation reservoirs, headworks, canals or drainage systems.

- Downstream fishermen in the event that the irrigation civil works impedes natural channels of fish migration to and from spawning grounds, or when previous fish spawning grounds are drained and converted to irrigated agriculture, or when over-intensive farming on irrigated fields leads to the run-off of chemical fertilisers or pesticides into the drainage water.
- Those living in salinity-affected delta areas, where reduced dry season stream flow due to abstractions for irrigation upstream increase the risk of intrusion by saline tidal waters.

Potentially negatively-affected impactees of landuse stabilisation, land development and rehabilitation measures in hilly and mountainous catchments (including the exclusion of all users from wildlife sanctuaries and nature conservation core zones) would include:

- Those previously dependent for a part of their livelihoods upon the garnering of natural resources from the forest.
- Those remote-area and highland residents whose current agricultural livelihoods depend upon slash and burn cultivation.

1.3 Hydrologic Pathways

The wet season cultivation of rice in bunded paddy fields has similar effects on basin hydrology as does the capture of run-off in hydropower reservoirs. Rainfall is trapped in bunded fields and re-evaporated or transpired to the atmosphere. During wet season dry spells, streamflow is redirected to paddy fields and also evaporated or transpired to the atmosphere. Dry season irrigation however has the opposite effect on basin hydrology to reservoir storage hydropower scheme operations, which augment downriver dry season stream flows. The dry season irrigation of rice in ponded paddy fields abstracts up to three times as much water from the river system as does the ditch and bed irrigation of alternative crops.

In poorly designed, poorly constructed or poorly managed, irrigation schemes, water consumption per unit area or per unit of product can be more than double that pertaining to schemes of a higher standard. In addition to impacts on hydrology, irrigation may also have ramifications for water quality, aquatic biodiversity, soil structure and soil fertility - the latter especially where saline horizons underlie fields not equipped with efficient surface drainage systems.

Expansion of wet season irrigation will augment the impacts of the NT2-HPP in ameliorating downstream flood levels in the Xe Bangfai Basin, along the Mekong mainstream floodplains, in the Great Lake Basin and in the Mekong Delta. This amelioration, if indeed significant, would be potentially advantageous to all tracts except for the Great Lake, where it would have a negative effect on the fishery due to reduction of the effective area of the lakeshore fish spawning grounds. Dry season irrigation, on the other hand, would have the opposite effect on river levels to that of operation of the NT2-HPP.

Irrigated agriculture is responsible for 80-90% of the water abstractions from the Mekong Basin waterways. Urban water supply and industrial use accounts for the remainder. Irrigation water is sourced from stored rainfall and runoff, stored floodwaters, pumping and diversions from rivers and streams including the Mekong, and to a smaller extent by pumping of ground water resources.

The Hydrologic Cycle

Water vapour in the atmosphere condensing into clouds is deposited on the land surface in the form of rain, snow, hail, dew, mist or frost. Through the hydrologic cycle, it is returned to the atmosphere via one or other of the following routes:

- Direct evaporation from the wetted leaf surfaces of terrestrial plants
- Precipitated atmospheric moisture enters the various water bodies through one or the other of the following routes:
 - *Direct surface runoff.* Runoff from undisturbed old-growth forest will have virtually zero suspended sediment. If a forest has been disturbed by exploitive logging however, or by clear felling, runoff may contain a certain amount of suspended sediment. Direct surface runoff from grassland is approximately double that to be expected from undisturbed, old-growth forest. If the grassland is burnt or over-grazed, runoff will contain suspended sediment. Direct runoff from sloping agricultural land will be very high in suspended sediment if soil erosion control measures are not installed. Runoff water cleanliness will also be compromised if excessive amounts of chemical fertilisers or pesticides are applied to the agricultural land. Suspended sediment and chemical pollution have a depressing effect on fish populations.
 - *Shallow aquifer.* Part of the precipitation, which is infiltrated into the soil and is not transpired into the atmosphere, may percolate laterally into the water bodies. The time taken for precipitation to reappear as stream flow varies with many factors such as: distance, slope and shallow aquifer transmissivity. Notwithstanding, percolation of heavy rainfalls into the soil horizon does have a significant flood peak amelioration effect.
 - *Deep Aquifer.* The portion of precipitation that penetrates deeper than the shallow aquifer on sloping terrain, may take several years to reappear as stream flow. Percolation into the deep aquifer is greatly facilitated by the presence of tall trees, whose roots penetrate and open up cracks in the bedrock and, when they die, provide the channels for deep infiltration.
- Direct evaporation from the surface of terrestrial water bodies, stream, rivers, lakes, ponds, wetlands, reservoirs or paddy fields.
- Transpiration by growing plants (note: this only occurs while soil moisture in the plant's root zone is above wilting point). Some deep-rooted trees may transpire moisture from the soil throughout the dry season whilst shallow-rooted grasses will cease transpiration by the end of the cool-dry season.
- The hydrologic cycle is completed by direct evaporation from the ocean, forming clouds that eventually deposit rain onto the land surface.

1.3.1 *Water Loss Mechanisms*

Prior to agricultural and infrastructural innovation by humankind, the entire land surface of the Mekong Basin was forested, ranging from mangrove forests in the Delta through swamp forests in the flood retention wetland, moist and dry evergreen forests on the better lowland and upland soils, dry dipterocarp forests on the thin shallow soils and coniferous forests on the higher slopes. Reservoir-impoundment hydropower schemes, such as the existing Ubon Rattana and Pak Moon Schemes in Thailand, the Nam Ngum I Scheme and the proposed Nam Theun 1, 2, and 3 Schemes in Lao PDR, impound wet season run-off and store it for hydropower generation in the dry season. Impoundment reduces average downstream river levels in the wet season, whilst the water released by power generation, increases the average dry season river levels.

In irrigation system terminology, 'water loss' refers to that amount of water diverted or pumped from the water source that leaks or evaporates en route to the roots of the crop and therefore does not contribute to transpiration through consequent growth. Such losses include:

- Seepage through the bottom or sides of canals,

- Overflows into emergency spillways or across tail regulators, due to poor operational procedures
- Discharges into drains.

Such losses are particularly serious economically when diesel fuel or electric power is expended in pumping water into the distribution headworks. It is only the evaporation and transpiration losses that represent a loss to the Basin's hydrological network however, as linkages, spills and drainage eventually return into the mainstream flow.

1.4 Irrigation

1.4.1 *Irrigated Cropping Regimes*

Since it was first domesticated thousands of years ago, rice has been the primary staple crop feeding the regional population.

The application of irrigation water to rice paddy fields has a three-fold purpose:

- Softening the soil to allow for easy and early cultivation with draught animals,
- Reducing the labour required for weed control by swamping those weeds not tolerant to waterlogging,
- Maintaining a constant rate of growth of the rice plants during dry intervals in the wet season.

Dry season irrigation enables the doubling or tripling of agricultural productivity when compared to farmland relying only on natural rainfall. The following list of Mekong Basin irrigated cropping patterns is illustrative, rather than exhaustive:

- Hot-wet season irrigated rice/cool-dry season stubble-grazing/hot-dry season stubble-grazing: this irrigated cropping pattern is practiced where the population density is relatively low, or the commandable water supply is insufficient to support dry season irrigation.
- Rice/stubble-grazing/rice: practiced in areas with local rice deficits, remote from markets for alternative crops with adequate stream flow or installed pumping capacity for dry season irrigation. The economics of this cropping pattern are questionable however, as irrigated dry-season rice requires up to three times the amount of irrigation water compared to alternative crops such as mung bean, soybean, peanut or forages.
- Rice/diversified crops/stubble-grazing: practised in the cooler, high altitude areas, where commandable stream flow is sufficient to irrigate into the cool dry season, but not into the hot-dry season. Diversified crops may include: sesame, potato, carrot, mung bean, peanut or soybean.
- Weed growth grazing and fishing/recession rice/stubble grazing: practised in areas where frequent flooding puts the wet season rice crop at risk. Fast-growing rice varieties are sown in the moist soil emerging from receding floods and may be given supplementary irrigation.
- Rice/rice/rice: practised in areas (such as the Cuu Long Delta) of high population density with convenient access to rice export markets and where the production of alternative crops is hampered by poor drainage.
- Sugarcane/sugarcane/sugarcane: practised in areas with good soils and plentiful irrigation water. Can be expected to expand if, as in Brazil, the demand for ethanol as a motor fuel increases with dwindling supplies of oil and natural gas.

- Rice/forage/forage: practised in the neighbourhood of feedlots in north Thailand. Can be expected to expand as population density forces livestock owners to convert from extensive free-range grazing to stall-feeding.

1.4.2 Crop Water Requirements

The art of irrigation is to supplement natural rainfall in supplying just sufficient water to the roots of the crop to keep it growing at the maximum biologically feasible rate throughout its lifespan. Different crops have different requirements in terms of quantity and timing for water application and have varying tolerances to waterlogging. Irrigation systems must be designed to provide the flows of water required by the most demanding of the crops that are likely to be grown and be able to drain off water promptly to prevent damage to those crops that are not tolerant of waterlogging.

Wet Season Rice

Ideally, this crop requires an initial application of irrigation water before the rains commence, to soften the soil for ploughing and to irrigate the seedling nursery. A further application is required at transplanting time, with water level in the paddy fields maintained at a depth of between 5 and 10 centimetres subsequently. The water should be drained briefly at tillering time and whenever fertiliser is applied. Five to ten centimetres water depth is maintained until about two weeks before harvest, when the fields are allowed to dry off. The quantity of water to be applied to an irrigated paddy field equates to that required for initial soil moistening, *plus* that lost to deep percolation below the reach of the rice roots, *plus* that evaporated from the free water surface, *plus* that transpired through the plants, *less* that derived from natural rainfall. One hectare of typical wet season rice crop returns some 9,000 cubic metres of water vapour to the atmosphere through evapotranspiration and requires a diversion of 5,000 cubic metres of irrigation water.

Dry Season Rice

One hectare of typical hot-dry season rice returns 8,000 cubic metres of water vapour to the atmosphere through evapotranspiration and requires a diversion of up to 15,000 cubic metres of irrigation water.

Fast-growing Dry Season Non-Rice Crops

One hectare of crop, such as peanut, mung bean or soybean transpires some 3,500 cubic metres of water vapour to the atmosphere, requiring the diversion of about 5,000 cubic metres of irrigation water.

Table I - 2 below provides estimates of the evapo-transpirative abstractions from the rainfall precipitating on the LMB catchments upstream of the Mekong Gauging Station at Kratie (at the head of the Cambodian Delta) due to irrigated cropping and rainfed agriculture in that sector of the LMB upstream of Kratie. The abstractions tabulated are attributable to all forms of landuse in the catchments, including irrigated agriculture. The area coverage of each type of landuse is also tabulated; in addition to evapotranspiration abstractions, the calculation of irrigation diversion requirements for each crop involves estimates of the additional losses due to leakage and spills from the conveyance and distribution systems, plus deep percolation into the shallow aquifer. Diverted water "lost" to crop production in this way is not lost to the stream flow however, but its re-emergence into the mainstream will be delayed according to such factors as distance from the mainstream and aquifer transmissivity. One millimetre depth of water on one hectare is equivalent to a volume of 10 m³.

Table 2: Estimated Evaporation plus Transpiration from Crop Plants (mm/day) and cropping areas in the Lower Mekong Catchments (km²)

Item	Crop	Month												Cropping Areas in the Lower Mekong Basin by Region (km ²)								
		Wet Season						Cool-Dry Season			Hot-Dry Season			Thailand		Vietnam CH		Cambodia *			Lao PDR	Total
		Ma	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	%	Area km ²	%	Area km ²	%	Area km ²	%	Area km ²	Area km ²
1	Swidden Rice	0	3	4	5	6	7	3	0	0	0	0	0	5	2,324	5	91	5	165	5	316	2,894
2	Bush Fallow	8	7	7	8	6	7	8	6	5	8	7	6	0	11,619	0	453	0	824	0	1,578	14,472
	<i>Total 1 - Shifting Cultivation</i>	8	10	11	13	12	14	11	6	5	8	7	6		13,942		543		988		1,893	17,366
3	Bunded Rain-fed rice, fast growing	4	6	7	7	7	4	2	0	0	0	0	0	25	9,927	25	395	25	751	25	955	12,029
4	Bunded Rain-fed rice, slow growing	4	6	7	7	7	6	4	2	0	0	0	0	75	29,782	75	1,186	75	2,254	75	2,865	36,087
	<i>Total 2 - Bunded Rain-fed rice</i>	8	12	14	14	14	10	6	2	0	0	0	0		39,709		1,581		3,006		3,819	48,116
	<i>Total 3 - Rainfed Rice (1 + 2)</i>	16	22	25	27	26	24	17	8	5	8	7	6		53,652		2,124		3,994		5,712	63,482
5	Irrigated rice, wet season, fast-growing	5	6	7	7	5	2	0	0	0	0	0	0	30	1,332	30	42	30	37	30	653	2,063
6	Irrigated rice, wet season, slow-growing	5	6	7	7	7	7	4	2	0	0	0	0	70	3,109	70	97	70	86	70	1,523	4,814
	<i>Total 4 - Irrigated Wet Season Rice</i>	10	12	14	14	12	9	4	2	0	0	0	0		4,441		138		123		2,175	6,878
	<i>Total 5 - Total Wet Season Rice (3 + 4)</i>	26	34	39	41	38	33	21	10	5	8	7	6		58,093		2,263		4,118		7,886	72,360
7	Irrigated rice, early dry season	0	0	0	0	0	5	7	6	5	7	2	0	25	390	25	35	25	31	25	330	785
8	Irrigated rice, main dry season	0	0	0	0	0	0	0	3	4	6	7	4	75	1,169	75	104	75	92	75	989	2,354
	<i>Total 5 - Fully-irrigated Dry Season Rice</i>	0	0	0	0	0	5	7	9	9	13	9	4		1,559		138		123		1,318	3,139
	<i>Total 6 - Total Rice</i>	26	34	39	41	38	38	28	19	14	21	16	10		59,652		2,401		4,241		9,206	75,499

		Wet Season						Cool-Dry Season			Hot-Dry Season			Thailand		Vietnam CH		Cambodia		Lao PDR		Total Area km ²
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	%	Area km ²	%	Area km ²	%	Area km ²	%	Area km ²	
9	Maize	2	4	4	3	0	0	0	0	0	0	0	0		3,832		870		541		410	5,653
10	Kenaf	3	4	4	4	4	3	0	0	0	0	0	1		269		0		208		0	477
11	Cassava	2	4	4	4	4	4	4	3	2	0	0	1		6,195		380		135		130	6,840
12	Upland soybeans	0	0	0	0	2	4	4	3	0	0	0	0		1,480		277		249		1,535	3,542
13	Upland mungbeans	0	0	0	0	3	4	3	0	0	0	0	0		185		35		31		192	443
14	Upland peanuts	0	0	0	2	4	4	3	0	0	0	0	0		185		35		31		192	443
15	Sugar cane	2	3	4	5	6	6	5	4	3	5	4	2		4,800		250		52		50	5,152
	Total 7 - Rainfed Non-rice Field Crops	9	15	16	18	23	25	19	10	5	5	4	4		16,946		1,846		1,247		2,509	22,549
16	Irrigated soybeans	2	0	0	0	0	0	0	0	3	5	5	5	0	376		210		330		70	986
17	Irrigated mungbeans	0	0	0	0	0	0	0	0	0	3	4	3	0	200		0		178		20	398
18	Irrigated peanuts	0	0	0	0	0	0	3	4	4	3	0	0	0	299		220		75		130	724
	Total 8 - Irrigated Non-rice Field Crops	2	0	0	0	0	0	3	4	7	11	9	8		875		430		583		220	2,108
19	Orchards/Plantations - Rainfed	6	5	5	5	6	6	5	4	4	6	5	4	95	3,620	90	2,700		1,640		420	8,380
20	Orchards/Plantations - Irrigated	6	5	5	5	6	6	5	5	4	7	7	7	5	191	10	300	0		0		491
	Total 9 - Orchards/Plantations	12	10	10	10	12	12	10	9	8	13	12	11		3,810		3,000		1,640		420	8,870
21	Coniferous forest Upper Dry Evergreen Forest	4	4	4	4	4	4	3	2	1	4	4	4	5	1,850	30	2,076	0	-	5	4,862	8,788
22	Forest Lower Dry Evergreen Forest	5	6	6	6	6	6	5	4	3	6	5	4	15	5,551	30	2,076	1	1,168	15	14,586	23,381
23	Forest	5	6	6	6	6	6	6	5	4	6	6	5	30	11,102	25	1,730	3	2,335	30	29,171	44,339

		Wet Season						Cool-Dry Season			Hot-Dry Season			Thailand		Vietnam CH		Cambodia *			Lao PDR	Total
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	%	Area km ²	%	Area km ²	%	Area km ²	%	Area km ²	Area km ²
24	Moist Evergreen Forest	6	6	6	6	6	6	6	6	6	6	6	6	10	3,701	5	346	15	1,168	10	9,724	14,938
25	Mixed Deciduous	3	4	6	6	6	6	5	4	3	2	1	1	20	7,402	10	692	20	1,557	20	19,447	29,098
26	Dry Dipterocarp	4	4	4	4	4	4	3	2	3	2	1	1	20	7,402	0	-	20	1,557	20	19,447	28,406
	Total 10 - Primary Forest	27	30	32	32	32	32	28	23	20	26	2	21		37,008		6,921		7,785		97,237	148,950
27	Bamboo Forest	7	6	6	7	5	6	7	5	4	7	6	5	1	1,850	1	461	1	311	1	2,559	5,182
28	Regenerating Forest	8	7	7	8	6	7	8	6	5	8	7	6	1	1,850	1	198	1	311	1	2,559	4,918
	Total 11 - Secondary Forest	15	13	13	15	11	13	15	11	9	15	1	11		3701		659		623		5118	10,100
	Total 12 - Tree-covered Land	54	53	55	57	55	57	53	43	37	54	4	43		44,519		10,580		10,047		102,774	167,921
29	High Altitude Grasslands	1	3	4	4	4	4	3	2	1	0	0	0	1	1,850	2	923	0.5	62	2	5,276	8,111
30	Wetlands	6	6	6	6	6	6	6	5	5	6	6	6	3	5,551	0.5	231	5	623	2	5,276	11,681
	Grand Total (6, 7, 8, 12)	91	102	110	116	116	120	103	76	63	91	7	65		166,401		23,331		24,558		222,498	436,819

1.4.3 *Irrigation System Typology*

To achieve maximum production potential, agricultural crops require that the soil in the root zone remains moist throughout the life of the crop. Irrigation is the act of applying water to cropland in quantities or at times over and above that derivable from natural rainfall incidence. Most crops, with the exception of rice and some aquatic species, require that, although moist, the root zone should also be aerated, i.e. not waterlogged. Drainage is the act of removing excess water from the soils.

Depending upon such factors as topography, water availability, soil type and type of crop, irrigation water may be delivered to the root zone either by droplet application to the soil surface, flooding the soil surface or by the lateral seepage from ditches or by sub-surface injection. The excess water may be removed from the cropland by dug drains or by pumping.

Table I - 3, itemises the main types of irrigation system found in the Mekong Basin, classified by water source and diversion, conveyance, distribution, application and drainage mechanisms.

The irrigation of rice in levelled, banded paddy fields is by far the most widespread system throughout the Mekong Basin. Various levels of increasing technological sophistication in rice irrigation systems may be observed.

Table I - 3: Irrigation System Typology

Water Source		Diversion Headworks		Conveyance Mechanism		Distribution System		Application System		Drainage System	
Code	Description	Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
	S		H		C		D		A		X
01	Direct Rainfall	01	Paddy field bund	01	Ditch	01	Direct	01	Ponded basin	01	Field to Field
02	Surface Run-off	02	Water harvest ditches	02	Embedded canal	02	Field to field from main canal	02	Ditch & bed	02	Drainage canal
03	Swamp/Lake	03	Free intake	03	Raised canal	03	Field to field from secondary canal	03	Watering can	03	Pumped
04	Dyke	04	Sluice	04	Pipe	04	Field to field from tertiary canal	04	Rain-gun	04	Tidal gate
05	Small Stream	05	Weir, non-technical			05	Quaternary ditches	05	Sprinkler		
06	Major Tributary Mekong	06	Weir, technical			06	Pipe	06	Mini-sprinkler		
07	Mainstream Dammed	07	Waterwheel					07	Drip		
08	Reservoir	08	Tidal gate					08	Soaker strip		
09	Groundwater	09	Reservoir gate								
		10	Low-lift pump, mechanical								
		11	Low-lift pump, hand								
		12	Low-lift pump, windmill								
		13	Electric pump, pontoon-mounted								
		14	Electric pump, bank-mounted								
		15	Electric pump, submersible								
		16	Diesel pump, pontoon-mounted								
		17	Diesel pump, bank-mounted								
		18	Pump - Unspecified								

Non-Technical Rice Irrigation Systems

Level 1

Levelling and bunding of fields to capture and store rainfall surpluses that would otherwise run-off directly. Rainfall thus stored in the cropped fields themselves is not usually sufficient to cater for dry spells during the wet season however, and crop yields may suffer due to water stress in the root zones. A variant of this system is used is that used in flood water reticulation wetlands; floating rice is broadcast into the fields before the flood season and is harvested using boats as the floods recede.

Level 2

The next level of sophistication is to dig ditches to divert runoff water from surrounding slopes into the bunded rice fields.

Level 3

Utilising native materials, simple diversion weirs are constructed across small streams and irrigation water conducted to the paddy lands through hand-dug hillside canals with simple outlets at intervals allowing water to flow from field to field. Depending upon stream flow, some dry season irrigation is usually possible on part of the commanded area. The weirs are subject to flood damage and must be repaired frequently, however.

If the water source stream is not deeply incised, then a weir may not be necessary - merely a free intake leading into a canal dug on one of the banks. The free intake may be gated to control water ingress.

Semi-technical Rice Irrigation Systems

Level 4

Permanent diversion weirs are of gabions or reinforced concrete construction, usually fitted with sand-sluices and conveyance-canal headwork gates. Where rivers are deeply incised, pumps may be installed instead of diversion-weir structures. Pumps may be diesel or electric-powered and be pontoon or bank-mounted. Bank-mounted electric pumps may be of inclined shaft or vertical shaft design or may have submersible motors. The latter may be reversible for evacuating rainwater from the command area at times when the river is in flood. In cases where reservoirs are installed to store wet season surpluses for dry season irrigation (which may be combined with hydro-electric power generation), the irrigation headworks may be part of the reservoir dam structure itself, or may be located downstream. Apart from the headworks capable of control of water ingressed to the system, a typical, semi-technical rice irrigation system would comprise an elevated main canal (which may be lined or unlined) delivering water through control gates into secondary distributaries whence water flows from field to field. Drainage is likewise field-to-field.

Even though there may be sophisticated headworks, if the conveyance canals are not raised so as to command all the irrigable area, and if there are no distributaries, the system is still classified as non-technical.

An idea of the order of magnitude of this altered energy consumption is given in Table I - 4, based on the parameters pertaining to three electrically pumped irrigation installations on the Nam Ngum tributary of the Mekong. In general, it may be stated that the savings in energy brought about by upgrading the conveyance and distribution efficiency of irrigation systems and the managerial capacity of the water users would far outweigh the influence of modified river levels. Cheap electric motors have low power factor ratings and thus consume more electricity per cubic metre of water pumped and with more expensive motors.

Table 3: Influence of Static Head variation on Irrigation Pump Energy Consumption

(parameters derived from Park Kha-nyung, Huay Chiam & Ban Phao Pump Irrigation Schemes on the Nam Ngum River)

No.	Parameter	Unit	Park Kha-nyung		Huay Chiam		Ban Phao	
			WS	DS	WS	DS	WS	DS
1	River level	masl	165.0	163.2	156.2	153.4	155.4	152.4
2	Total head	m	14.0	15.2	18.8	20.8	24.5	26.5
3	Discharge	l/s	400	375	380	350	260	250
4	Effective power	kW	54.94	55.92	70.08	71.42	62.49	64.99
5	Pump efficiency	%	72.0	73.7	74.7	76.6	73.0	74.0
6	Motor efficiency	%	92.5	92.5	93.0	93.0	90.0	90.0
7	Power factor	%	88.0	88.0	88.0	88.0	88.0	88.0
8	Input power	kW	93.74	93.21	114.63	113.93	108.08	110.89
9	Pump specific energy consumption	kWh/m ³	0.0651	0.0690	0.0838	0.0904	0.1155	0.1232
10	Conveyance efficiency	%	75	75	75	75	50	50
11	Distribution efficiency	%	80	80	80	80	80	80
12	Field specific power consumption	kWh/m ³	0.1085	0.1151	0.1397	0.1507	0.2887	0.3080
13	Rice field water requirement	m ³ /ha/crop	5,000	10,000	5,000	10,000	5,000	10,000
14	Non-rice field water requirement	m ³ /ha/crop	-	4,000	-	4,000	-	4,000
15	Electricity consumption - rice crops	kWh/ha/crop	542	1,151	698	1,507	1,443	3,080
16	Electricity consumption - non-rice crops	kWh/ha/crop	-	460	-	603	-	1,232
17	Low river electricity consumption - rice crops	kWh/ha/season	575	1,151	753	1,507	1,540	3,080
18	Incremental energy consumption	kWh/ha/crop	33	-	55	-	97	-
19	Static head differential	m	1.8	-	2.8	-	3.0	-
20	Incremental energy consumption	kWh/ha/masl/crop	18.3	-	19.7	-	32.2	-
21	Incremental energy consumption	%/masl	3.4	-	2.8	-	2.2	-
22	High river, rice irrigation energy consumption	kWh/ha/crop	-	1,085	-	1,397	-	2,887
23	Decremental energy consumption	kWh/ha/crop	-	66	-	110	-	193
24	Pro rata Decremental energy consumption	kWh/ha/masl/crop	-	36.6	-	39.4	-	64.5
25	Relative decremental energy consumption	%/masl	-	3.2	-	2.6	-	2.1

PUMPING PARAMETERS - EXPLANATORY NOTES

1	<p><i>River level (masl)</i>: being the average wet season (excluding floods) and dry season river levels pertaining at each of the three sub-project pumping stations.</p> <p>Park Kha-nyung & Huay Chiam schemes have bank-mounted, inclined, pump installations with electric motors and switchboards located above maximum flood level. Pumps are permanently submerged, mixed axial flow type, driven by drip-feed oil bath-encased, long shafts turning in bronze bushings. There are four pump/motor units at each installation (90 horsepower (h.p.) each at P. Kha-nyung, 100 h.p. each at H. Chiam). The Ban Phao installation has 4 pontoon-mounted, single-stage centrifugal pumps, direct-coupled electric motors. The pumps discharge through flexible rubber hoses, coupled to inclined, steel, bank-mounted pipe (with alternative tapping points to cope with gross changes in river level). At each station, the four outlet pipes discharge into a single concrete stilling basin, equipped with staff gauge and</p>
---	---

	Dipoletti measuring wheel at the head of the main canal.
2	<i>Total head (m)</i> : is the sum of Static Head (difference in metres between the elevation of the river surface and the discharge point at the stilling basin) PLUS the Friction Head (the resistance to flow to be overcome arising from interaction between the moving water column and the containing pipe and to angular changes in flow direction) PLUS Acceleration Head (the resistance of the pumped water to being accelerated from zero velocity in the river, to the velocity of the flow column in the discharge pipe).
3	<i>Discharge (l/s)</i> : is the volume of pumped water delivered to the stilling basin each second by each pump. Electric motors turn at constant speed and accordingly discharge more water per unit of time as river level rises, thus reducing static head. The relationship is not linear, however, as Friction Head and Acceleration Head (i.e. resistance) increase disproportionately with the velocity of the pumped water in the discharge pipe.
4	<i>Effective power (kW)</i> : derived by multiplying the supply voltage (380 V) by the electric current (measured in Amperes) that would be drawn in order to pump a delivered output against the total head, by a 100%-efficient pump driven by a 100%-efficient motor. The resultant figure is divided by 1,000. Note: 1 horsepower is equivalent to 760 Watts, i.e. 1 kW = 1.32 h.p. For riverside paddy rice irrigation along the Mekong, roughly 1 h.p. of installed capacity is required per hectare irrigated.
5	<i>Pump efficiency %</i> : this is a function of pump design, with respect to internal friction and acceleration losses. It represents the percentage of the total energy applied to the pump that is actually utilised for delivering water as compared to what would be delivered if a pump could have no internal friction and acceleration losses. Inclined axial-flow pumps are generally more than efficient bank-mounted pumps.
6	<i>Motor efficiency %</i> : the percentage of the applied electrical energy that is actually converted into useful work, compared to the work that would result if there were no electrical resistance in the motor windings (the latter results in heating, which has to be dissipated by a cooling fan).
7	<i>Power factor %</i> : this value represents the amount of energy applied to the motor that results in useful work, compared to the work output that could be obtained if there were no magnetic inductance losses in the cores of the rotor and stator motor windings. These losses are due to contrary magnetic fields induced in the cores, which tend to resist, rather than assist, the rotation of the motor. Maximum power factor is achieved in the most expensive motors by utilising very thin slices of cold-rolled silicone steel laminations for the armature cores.
8	<i>Input power (kW)</i> : this is the power actually applied by each motor in effecting the rate of water discharge pertinent to each river level. It is the product of the input voltage (380 V) multiplied by the metered current draw (Amperes) divided by 1,000. The difference between value between <i>Input power</i> and <i>Effective power</i> reflects the losses due to pump and motor inefficiency.

9	<p><i>Pump specific energy consumption (kWh/m³):</i> Electrical energy is metered and charged for in “Units”, each of 1-Kilowatt hour (kWh). The energy consumed per cubic metre of discharge to the stilling basin varies with river level.</p> <p>For example, at average wet season river level the bank-mounted pumps at Pak Kha-nyung each consume 0.0651 kWh per cubic metre discharged; at average dry season river level; the energy consumed per cubic metre discharged rises to 0.0690 kWh, an overall increase of 6.0%. This equates to an average of 0.0039 kWh extra energy consumption for each 1-metre decrement in river level. At Ban Phao, average wet season river level the pontoon-mounted pumps each consume 0.1155 kWh per cubic metre discharged. At average dry season river level, the energy consumed per cubic metre discharged rises to 0.1232 kWh, an overall increase of 6.7%. This equates to an average of 0.0077 kWh extra for each 1-metre decrement in river level.</p>
10	<p><i>Conveyance efficiency %:</i> the proportion of water discharged into the stilling basin that enters the inlets of the secondary canal. Pumped water may be lost during conveyance by seepage or over-flowing into emergency spillways, or through tail regulators. The Pak Kha-nyung and Huay Chiam main canals are elevated and were well compacted during construction. Seepage losses are therefore relatively low. They are not, however, equipped with regulating ponds, so that overflows may occur when, for instance, 3 pumps cannot meet the daily irrigation demand, but turning on the 4th pump discharges more than can be distributed to the fields. At the time of calibration, the Ban Phao main canal suffered high seepage losses due to sub-standard design and inadequate compaction during construction; neither did it have a regulating pond. This canal has recently been re-compacted, concrete-lined and a regulating pond installed.</p>
11	<p><i>Distribution efficiency %:</i> the proportion of the pumped water entering the secondary canal inlets that eventually reaches the field to be irrigated. Losses involved include secondary, tertiary, and quaternary canal seepage and fail-regulator overflow. In contrast with the majority of stream diversion and pumped irrigation projects in Lao PDR and with many in Thailand, the Ban Phao, Pak Kha-nyung and Huay Chiam schemes are all equipped with very efficient water distribution and control systems. The double orifice, constant head, inlet-based on the secondary and tertiary canals can be calibrated for volumetric measurement. Standard orifice farm inlets are provided at intervals along the tertiary canals whence the water is channelled through hand-dug quaternary ditches to each irrigated field. By contrast, most of the older pump irrigation projects in Lao PDR (including Xe Bangfai Basin) have embedded, rather than raised, main canals and few secondaries, tertiaries or quaternaries, also few, if any, volumetric control gates. Conveyance and distribution efficiencies are therefore very low and consequently, commanded area per installed horsepower is also low. Most of the conveyance and distribution efficiencies of Thai pumped irrigation systems are higher than the average for Lao PDR.</p>
12	<p><i>Field specific power consumption (kWh/m³):</i> the energy consumed in pumping the water arriving at the field boundary, together with the volume of water lost during conveyance and distribution, expressed as kWh/m³ of irrigation water delivered to the farm inlet.</p>
13	<p><i>Rice field water requirement (m³/ha/crop):</i> at the start of the cropping season, the paddy field must be flooded with water to soften the soil for ploughing and harrowing and to irrigate the seedling nursery. The field is then irrigated again for transplanting and the water level maintained at a depth of 10 cm throughout the growing season with the exception of a field allowed to dry on two occasions: one for fertilising, and the other to stimulate tillering of the rice plant. Fields are drained again about two weeks before harvest. Hence the field water requirement for rice is the sum of the nursery requirement, <i>plus</i> the cultivation requirement (puddling requirement), <i>plus</i> the water required to replace that evaporated from the pond surface, <i>plus</i> that transpired through the crop leaves, <i>plus</i> that percolating downwards beyond the root depth, <i>less</i> the effective rainfall, i.e., the amount of rainfall that does not overflow the bunds and therefore augments irrigation water deliveries. The field water requirement figure used in this sample table are broad assumptions.</p>
14	<p><i>Non-rice field water requirement (m³/ha/crop):</i> the assumed figure adopted here, refers to a range of fast-growing, short-season crops that may be planted in Lao PDR or North-east Thailand as an alternative to dry season rice. They include maize, mung bean, peanut, soybean, tobacco, chillies, vegetables for seed, green vegetables, cucurbits, etc. They do not include tall crops such as sugarcane or Napier Grass, which may occupy the land for 12 months or more. Because these crops are irrigated using the ditch-and-bed technique, deep percolation losses (and consequently aquifer recharge) do not occur.</p>

Technical Rice Irrigation Systems

Level 5

A fully technical rice irrigation water delivery system has the following features: i) gated, primary, secondary and tertiary conveyance canals, raised sufficiently above the surrounding terrain to be able to command all potentially irrigable land; ii) Quaternary canals able to deliver water to each farm individually, irrespective of the cropping regime of others; iii) Quaternary drains able to remove water from individual farms, irrespective of the drainage requirement of others.

Level 6

The ultimate level of sophistication in rice irrigation systems would exhibit the following features: i) Water-metering devices. Water-metering contributes to cost recovery and water use efficiency by measuring the volume of water delivered to each farmer so that he may be charged accordingly (note: Charges for irrigation by the hectare leads to profligate water-use as each farmer tries to maximise the volume he receives for the money paid). A typical metered irrigation system may incorporate a staff gauge and Cipoletti measuring weir at the headworks, double-orifice adjustable gates at the head of each tertiary canal and standard orifice measuring boxes at each farm inlet. The time of each delivery of water to the farm is measured and multiplied by the cubic metres per minute system parameter in order to determine total volume delivered per location and the corresponding fee to be levied. Alternative systems may employ constant volume delivery flumes or Dethridge wheels.

To prevent canal overflows due to imbalance between supply and demand, fully sophisticated electrically-pumped irrigation schemes will have a regulating pond installed in the main canal, between the pump and the service area.

Reservoirs

Dammed Stream Reservoirs

Multi-purpose Reservoirs

These have the dual function of generating electricity as well as providing water for irrigation. Some have the prime purpose of power generation with irrigation as an incidental, while others are vice versa. With the former type, there is a risk that hydropower generation regimes take precedence over irrigation requirements, with the result that flooding of croplands may occur from reservoir overflows or irrigation water deficiencies may occur at times of generator shutdown.

Flood-capture Reservoirs

Swamp storage banks are built around back swamps in riverine floodplains and fitted with sluice gates that allow ingress of floodwaters for regular release to nearby irrigated fields during the dry season.

Dykes

These may be installed on gently sloping flood-prone terrain and are found particularly on the northern shore of the Tonle Sap in Cambodia. They are submerged at high lake levels and as the waters recede in the early dry season, rice is planted on the exposed lake shores to receive supplementary irrigation by gradual release of the waters impounded by the dykes.

Tidal Irrigation

The doubling of population that has occurred in the Lower Mekong Basin (LMB) over the past thirty years, has led to the extension of agricultural landuse into increasingly fragile habitats. One of these is the Mekong Delta where inferior peat

soils and acid sulphate soils have been cajoled into rice production through the expedient of canalisation, bunding and the installation of tide-control gates. At high tide, freshwater from the Mekong River is conducted into the rice fields and impounded by closing the gates. When drainage is required, the gates are opened at low tide.

Stream Diversion Irrigation Weirs

Large contiguous tracts of riverside banded paddy field, groups of farmers, often from several contiguous villages, banded together to construct and maintain stream diversion weirs fashioned out of native materials, such as: large rocks, logs and stakes driven into the riverbed with wooden mallets. River water was led to the paddy fields via hand-dug canals and, to provide a guarantee against crop failure should the rains fail at any period during the wet season, an additional second irrigated crop of rice or other commodities could also be cultivated. Irrigation system operation and maintenance needed rules and continued cooperation between several villages, so the chieftain organising all this eventually became a prince and his place of residence became the local capital. Agricultural and forestry products were exchanged for silver and gold; wealth accumulated and the village became a royal city, fortified with bricks and mortar, complete with temples and monuments glorifying the leading elite.

Weirs have the disadvantage that they are subject to flood damage, requiring frequent repair, and also impede navigation. Water extracted by weirs for dry season irrigation, does not reappear in the river in the same season, so that dry season river levels are accordingly lowered.

Irrigation and the Environment

When taking decisions concerning the expansion of irrigation networks, the following environmental checklist should be considered:

A: Project Siting. Is the project area adjacent to or within any of the following environmentally sensitive areas?

- 1) Protected Area
- 2) Wetland
- 3) Mangrove
- 4) Estuarine Area
- 5) Buffer zone of Protected Area
- 6) Special Area for protecting biodiversity.

B: Potential Environmental Impacts. Will the project cause:

- 1) Loss of precious ecological value, e.g. result of encroachment into forests, swamplands or historical/cultural buildings, disruption of hydrology of natural waterways, regional flooding and drainage hazards
- 2) Conflicts in water supply rights and related social conflicts
- 3) Impediments to movement of people or animals
- 4) Potential ecological problems due to increased soil erosion and siltation, leading to decrease in stream capacity
- 5) Insufficient drainage, leading to salinity intrusion
- 6) Over pumping of groundwater leading to salinisation and ground subsidence
- 7) Impaired downstream water quality and therefore impairment of downstream uses of water
- 8) Dislocation or involuntary resettlement of people
- 9) Potential social conflict deriving from land tenure and land use issues
- 10) Soil erosion after compaction and lining of canals
- 11) Noise from construction equipment
- 12) Dust

- 13) Labour-related social problems, especially if workers from different areas are hired
- 14) Waterlogging and soil salinisation due to inadequate drainage and farm management
- 15) Leaching of soil nutrients and changes in soil characteristics due to excessive application of irrigation water
- 16) Reduction of downstream water supply during peak seasons
- 17) Soil pollution, polluted farm run-off and groundwater and public health risks due to excessive application of fertilisers and pesticides
- 18) Soil erosion (gully, sheet)
- 19) Scouring of canals
- 20) Clogging of canals by sediments
- 21) Clogging of canals by weeds
- 22) Seawater intrusion into downstream freshwater systems
- 23) Introduction of increased or increasing water-borne or water-related diseases.

1.4.4 *Irrigation Mechanism*

Irrigation Application Methodologies

Modification of river flow regimes downstream of a trans-basin diversion will reduce average water levels downstream of the dam and raise average water levels downstream of the power station. More pumping energy is therefore required to deliver crop irrigation water requirements downstream of the dams and less downstream of the powerhouse.

Ponded Basin Technique

This technique is applied for crops that can stand prolonged waterlogging of the root zone, planted in levelled, banded paddy fields (rice, kenaf, Sesbania, soybean, etc.).

Ditch-and-Bed Irrigation

This methodology can be applied in banded paddy fields for non-rice crops, non-tidal swamps on non-banded flatlands and on terraced slopes. Crops that cannot tolerate waterlogging in the root zone are planted on raised beds interspersed with ditches into which the irrigation water is introduced. These ditches may also serve for drainage of excess rainfall. Water is applied to crops, either by spraying from watering cans filled from the ditches, by scooping from the ditches and throwing the water over the crop beds or by allowing the water to infiltrate laterally from the ditches directly into the root zone.

Basin Terraces

When fruit trees are planted on sloping lands, a small circular or square level basin or “mini-terrace” may be built around the tree, with a bund to hold water in the terrace. Irrigation water may be applied to the basin terrace from the water reservoir or pump by hose or by small surface ditch.

Sprinkler Irrigation Application

Watering Can

It is a common practice for a small farmers living close to rivers, streams, dams or ponds, to make dry season gardens on the banks, often temporarily fenced, for the cultivation of vegetables: maize, tobacco, chillies, herbs and other spices. These are watered by watering can fitted with a shower spray nozzle. The cans are filled from the stream and often carried in pairs on a shoulder pole. When the crops are grown on riverbanks and islands it is only necessary to water them in the early growth stages until the roots can tap the shallow water table beneath.

A variant is to grow crops on the tops of levees and pump water into a small pond whence the watering cans are filled.

Pressurised Sprinkler Systems

When high-value crops are grown on commercial estates, investment may be made in pumped sprinkler systems, which may be of the following types:

Rain Gun: this is a large-diameter single jet, which rotates slowly, watering a large circle of crop. Rain guns may be set in one place or self-propelling.

Pipeline Sprinklers: small rotating sprinklers are set at intervals along lightweight, portable paths, which are laid between crop rows, or are self-propelling above the crop rows.

Mini-Sprinklers: individual mini-sprinklers are placed under individual fruit trees and supplied by small diameter flexible plastic pipe. Whereas rain guns and pipeline sprinklers are subject to high evaporation losses, the jets of mini-sprinklers are shaded by the trees with minimal evaporation loss.

Drip Systems: plastic pipes or hoses with drip-nozzles inserted at intervals are laid in individual beds of high-value horticultural crops. They have the advantage of zero evaporation loss and do not wet the leaves of the crop, thus reducing the risk of fungal attack. They are quite capital intensive however, as they require elaborate filtration systems.

Water Conveyance Mechanisms

Irrigation delivery conveyance mechanisms are those structures that convey stored, diverted or pumped water from the headworks to the margins of the fields to be irrigated. Drainage water-conveyance mechanisms are those structures conveying excess rainfall or drained water from the edges of the crop fields to be disposed of in a natural water body.

Dug Canals

These are canals (or ditches) dug into the terrain, with the excavated soil heaped or spread on one or both sides. When delivery canals are dug on river levees or on hillsides, they may command the surrounding fields and irrigate them by gravity. When dug on low-lying lands, irrigation water may have to be pumped from the canals into individual fields. When negotiating areas of permeable subsoil, dug canals may need to be concrete-lined to prevent excess seepage loss.

Raised Canals

In order to command wide irrigable areas or to cross depressions, irrigation water conveyance canals are raised above the level of the local terrain. This is done by constructing a consolidated roadway with imported materials and excavating the canal in the centre, or to one side of the roadway, disposing of soil on the batters. Provided that the construction materials are carefully selected for adequate clay content, and that consolidation is carefully supervised, elevated canals do not leak and do not require expensive concrete lining.

Pipes

Small-scale orchard or garden irrigation systems, particularly on sloping land, convey water from pump to distribution points through pipes that are usually buried. Pipes are expensive, but have the advantage of minimal water loss and zero maintenance requirement.

Irrigation Water Distribution Systems

Field to Field

Water is released through a pipe or a gate in the side of the main canal and allowed to flow from paddy field to paddy field throughout the entire irrigated area. Disadvantages are that the fields near the canals may be over-watered, whilst those furthest away are under-watered. Under this system, portable siphon pipes are sometimes used to draw water from the main canals.

Branch Canals

Raised secondary and tertiary canals are constructed throughout the command area with usually hand-dug quaternary canals or ditches leading water to individual fields and leading drainage water from individual fields to tertiary, secondary and primary drains. In cases where secondary and tertiary canals are dug rather than embedded, then pumping, either hand-powered or diesel-powered, must be used to raise the water from the canals to the individual fields. In some coastal areas with constant sea breezes, wooden "dragon-bone" pumps powered by windmills may be used to elevate water from canals into irrigated rice fields or to salt-evaporation pans.

2 PART 2: PRESENT STATUS OF LANDUSE & SHORT-TERM TRENDS

2.1 Introduction

The growth of the rural population, but with insufficient parallel support to poverty alleviation and capacity building, is leading to the largely unplanned expansion of extensive agricultural landuse at the expense of forested land and wildlife habitats and a consequent negative impact on fisheries. Growing urban populations with accompanying economic aspirations and increased appetite for food, natural resources, also leads to agricultural expansion, diminution of the forested area, over-exploitation of the fisheries and atmospheric and water pollution from industrial wastes. To reverse this downward spiral to the benefit of both present and future generations, it is necessary to take the following actions in both rural and urban areas:

- agricultural sedentarisation accompanied by soil erosion control in uplands and highlands with slopes less than 25%;
- sustained yield forest and plantation management for production and community forests;
- community-based natural resources management with buffer zones surrounding biodiversity core zones and watershed protection forests;
- community-based sustained yield management of riverine, lacustrine and estuarine fisheries;

Conservation forest landscapes and their connectivity corridors for all countries in the Basin have been identified, some of them gazetted and some of these brought under more or less effective management. To conserve the long-term integrity of the biodiversity resources of the region, it will be necessary to establish a chain of inter-connected, effectively managed, wildlife sanctuaries and national parks surrounded by buffer zones, wherein the population is enabled by agricultural development and a share in income from forestry, to live above the poverty line without any further justification to trespass on the protected area.

In the Mekong Basin hunting and gathering can sustainably support no more than two persons/km². Pioneer swidden cultivation is untenable because of worsening watershed degradation. Cyclic re-occupance swidden cultivation can sustainably support no more than 20 persons/km², while erosion-protected rainfed arable agro-forestry can support up to 100 persons/km². Irrigated fields, on the other hands, when commanded by a year-round water supply delivered by a state-of-the-art canal network, with provision for drainage at will, can support in excess of 2,000 persons/km², albeit with atmospheric and hydrospheric environmental penalties inherent in mechanisation and the utilisation of imported fertilisers and pesticides.

Irrigation system rehabilitation, expansion and upgrading therefore is the key to restoring man/land balance in the Basin, provided that it does not expand into sensitive wetland habitats or potentially saline areas. To ensure the longevity of the irrigation water supply, concurrent attention must be diverted to stabilising landuse in the catchments through contouring, terracing, forest regeneration, land titling and the legalisation of incorporating income from village forestry into the farm family cash flow. Investment in irrigation *per se* is expensive, but when

viewed in the context of the number of people that it can feed, and the parallel economic returns from the sustained yield management of the forest land that irrigation development releases from agricultural pursuits, then the combined internal rate of return is quite attractive.

2.2 Basin-wide Perspectives

Areas currently used for irrigated rice in the Lower Mekong Basin vary considerably between the countries, with the largest areas found in Cambodia where double rice cropping is common - with two harvests in the dry season and one in the wet season. About half of Cambodia's dry season irrigated rice area is recession rice, whilst about ten percent of the wet season area is floating rice. Probably less than half of the area of irrigated dry season rice in Cambodia is fully irrigated. The rest of the area is planted to recession rice, which derives half of its moisture requirements from the water remaining in the soil horizons after flooding and thus requires only half the amount of applied irrigation water when compared to dry season rice grown on non-flooded lands. The amount of water vapour transpired to the atmosphere is comparable in both cases, however.

Table 4: Irrigated Dry Season Rice in the LMB and Predicted Increase (km²)

Type of Crop/Land	Thailand	Lao PDR	Vietnam Central Highland	Mekong Delta	Cambodia	Total
Irrigated dry season rice (2000)	1,070	920	370	34,030 ¹	2,510	38,900
Predicted situation (2025)	1,200	2,000	400	35,700	5,000	44,300
Increase	10%	100%	0	5%	100%	14%

Source: Lower Mekong Basin, Future Trends in Agricultural Production (MRC, 2003)

¹ Includes double cropping in dry season

Note: It is suspected that the MRC data concerning potential irrigation expansion may involve transgressing some currently forested wetlands, which would have adverse impact on the fisheries. This should be investigated more closely by detailed analysis of remote sensing information.

The potential for expanding dry season irrigated rice is also unevenly distributed between the countries. In the lowlands of northern and northeastern Thailand, it is assumed that the future dominant production will be low input, low risk, wet season rainfed and irrigated rice production. The area of irrigated dry season rice did not increase from 1990 to 2000 and expansion in the future is expected to be limited, unless the economic returns from irrigated rice are improved - either through technological advances such as higher yielding varieties, cultural practices, or higher farm gate prices. Expansion of irrigated sugarcane area for the production of ethanol for motor fuel and bagasse for steam-powered electricity generation could be expected; so could expansion of the current trend to irrigate small areas of high value crops, such as vegetable seed and fruits. Rehabilitation and upgrading the efficiency of already installed irrigation systems would be more recommendable than expansion of irrigated area onto more marginal soils.

Seen against this background a fair guess of the future expansion is that it would be limited to 10% of today's area over a 20-year period; this would mean an additional area of around 100 km². A large percentage of the potential arable land has already been converted to agricultural purposes in the Vietnamese part

of the Mekong Delta. Of the total area of flat land and gentle slopes, 88% is utilised for agriculture and settlements. Both the lack of suitable land and the limited profitability of growing rice presently discourage further expansion of dry season rice cropping in the Mekong Delta. Instead, the current trend is to devote land to more profitable products such as fruit trees and fish and prawn ponds augmented by fish cage culture. Accordingly, only small increases in dry season rice cropping can be expected in the future, possibly limited to around 5% in the next 20 years.

The Central Highlands of Vietnam are also in a similar situation as regards land utilisation and potential for increased irrigated rice area. Conversion of land for agricultural purposes is likely to continue with a focus on orchards and other crops that give higher returns than rice cultivation. The future expansion of irrigated dry season rice in the Central Highlands is therefore likely to be limited. Sprinkler irrigation of coffee, vegetables and fruit orchards by pumped groundwater is facing problems of aquifer depletion and is thus likely to retract rather than expand.

The countries that possess the most significant potential areas for expanded rice cultivation are Lao PDR and Cambodia. Lao PDR has between 20,000 and 30,000 km² of flat and rolling land that could be utilized for agricultural purposes. Possibly as high as 50% of the soils of this land type are infertile and poorly suited for agriculture but there are possibly nearly 10,000 km² of more-fertile land. Most of these high potential areas are located on floodplains of the Mekong tributaries in the central and southern part of the country. The expansion of dry season irrigated agriculture (including forage crops for more intensive livestock raising) will in the future mostly be on already existing paddy field areas, plus expansion of irrigation civil works to currently rainfed arable farmland on gentle slopes. The pace of expansion of irrigated area will depend mainly on the pace of rural electrification for pumping because by now, most of the conveniently exploitable stream diversion gravity irrigation opportunities have already been availed of. Given the donor-driven characteristics of the Lao PDR economy, the availability of investment capital for civil works will probably not be problematic, but funds for maintenance and repair works will be, if planning does not take full account of the economics of irrigated agriculture, hand in hand with demographic projections. Given the ample availability of suitable land, a doubling of today's area within 20 years may be possible. This would mean an area of around 2,000 km² of dry season irrigated crops by 2025.

In eastern and southern Cambodia more than 4,600 km² of relatively good agricultural land are located on the Mekong floodplain. Much of the land in southern Cambodia is flood prone, however. In the Great Lake region, around 7,500 km² of reasonably fertile land can be found but much of the potential land is either isolated or consists of flatlands where water storage is problematic. Exploitation of groundwater by tube well pumping would therefore present the only mechanism capable of expanding dry season irrigation. Apart from the high investment and operational costs involved, tube well irrigation involves risks of potential salinity or underground water pollutants such as arsenic, together with high operational costs. Before deciding to expand irrigation, other options, such as deep-rooted tree crops which can tap the shallow aquifer during the dry season should be considered, and their relative economic feasibility compared. There are some 2,000 km² of such land awaiting agricultural intensification (including orchards, farm forestry, etc.) in Cambodia.

For example, on similar country in northern Central Thailand, banded rainfed paddy fields have been provided with drains and planted with fast-growing *Eucalyptus* and *Acacia* trees for pulpwood. There is a growing demand for wood

fibre in Southeast and East Asia. Fast-growing trees can be inter-planted with upland rice in Year 1, with peanut in Year 2 and can be inter-sown with forage grasses for grazing cattle in Years 3 and 4. The pulpwood is harvested in Years 6 or 7 and either ratooned or replanted. Bamboo plantation is another possibility. In Lao PDR, the ADB Industrial Tree Crops Loan Project involving the private sector (including smallholders) is entering its second phase.

In Thailand, a consortium of universities and local consultants is designing a nation-wide campaign of irrigation system upgrading and sustainable expansion of rainfed irrigation onto sloping lands adjacent to irrigation schemes.

The intensification of land-use and development of the irrigation potential in the Basin are not expected to contribute significantly to cumulative effects on the hydrological regime caused by other development sectors.

2.2.2 *Trans-basin Diversions*

Trans-basin hydropower schemes are potentially more impacting than are single basin reservoir schemes; Run-of-River schemes are potentially least impacting. Trans-basin schemes drastically reduce the depth and flow in the donor river (except during floods) for considerable distances downstream of the diversion dam.

Main impacts are on local navigation and fishery with some knock-on effects on terrestrial wildlife. Local water tables may be lowered and the energy input required for pumping water out of the river increased (see Table I - 4). Potential positive impacts are increased scope for stream bank and sandbar gardening in the dry season and increased opportunities for panning gold and other heavy metals. Potential adverse impacts in the recipient river include marginally increased wet season flood levels, flooding of dry season stream bank gardens, extermination of sandbar-inhabiting wildlife (e.g. turtles), fishery species composition will be modified, fishing technologies may have to be altered but the overall impact on fisheries would probably be positive. Energy cost for pumping irrigation water to the top of the bank would be slightly reduced; severity of flooding in both donor and recipient rivers depends on the reservoir and power station operational regime.

Mainly, due to widespread deforestation of the catchments, rural population growth and rapid urban industrial development, the Chao Phraya Basin in central Thailand experiences dry season water shortages. Many of the urban groundwater supplies extract fossil water, which is non-renewable. There is a proposal under consideration to divert water from the Kok and Ing Rivers in the Mekong Basin via a tunnel to the Nam River in the Chao Phraya Basin.

A large portion of northeastern Thailand has topography reasonably suitable for agricultural cultivation but suffers a six-month long dry season with virtually no rainfall. Fossil groundwater urban supplies are also near exhaustion in some centres. Various proposals have been considered for diversion of part of the flow of the Mekong mainstream or major tributaries into the Chi River Basin. These include the Pa Mong Dam across the mainstream, upstream from Vientiane, and diversion of the Nam Ngum and Xe Bang Hieng in Lao PDR via tunnel passing under the Mekong into the Chi Basin in northeast Thailand. Part of Savannakhet Province in central Lao PDR is similarly in rain shadow and one of the proposals considered has been to pass the NT2-HPP turbinated discharges via aqueduct across the Xe Bangfai and into the Savannakhet Plains. It is understood that the Pa Mong Project idea has been abandoned due to the large number of villages that would need resettlement. Generally poor soil quality and the risk of salinity in both northeast Thailand and Savannakhet make the long-term viability of these trans-basin diversions questionable.

2.2.3 *Predicted Impacts of Agriculture*

Agriculture in the Lower Mekong Basin is expected to intensify rapidly due to the pressure of increasing populations. The risk is that history will repeat itself and lands that are better suited to forestry or conservation will be utilised for rainfed agriculture without adequate erosion protection precautions. This would result in soil and ecosystem degradation - some of it irreversible.

Neither China, Thailand, nor Vietnam has lands suitable for agricultural expansion; land use in China and Vietnam is already very intensive and further sustainable intensification is questionable. Development plans for the Delta include increased production and diversification of cash crops.

The most important water management issues in the Delta are dry season water shortage combined with saltwater intrusion. During the dry months March through May, peak irrigation demand coincides with the lowest flow volume in the Mekong distributaries.

During the dry season, brackish tidal waters move into the deltaic distributaries and canals; the highest salinity is usually observed in April. Currently about 1.7 million ha of the total Vietnamese delta area of about 4 million ha is affected by saltwater intrusion. This affects irrigation and domestic water supply and sets a limit to further expansion of irrigation systems. Operation of the NT2-HPP would alter the flow regime so that on average, the number of days per year with negative flow at Tan Chau would be reduced and thus have a beneficial but very slight effect on salt water intrusion and consequently the suitability of water for irrigation.

In the **5-year** perspective, the period with negative discharges (water flowing upstream due to high tide and low flow) at Tan Chau would be reduced to 8.4% of the time from 9.5% in the baseline. The positive effect on more water available for irrigation will increase accordingly.

2.2.4 *Ongoing & Planned Irrigation Upgrading and Expansion*

In that construction contractors are always seeking continuity of business and engineers hold sway in most of the riparian countries irrigation departments, there is a general tendency to "build first and justify afterwards". Projects are planned for wherever there is a topographical, hydrological and technical feasibility to install dams, weirs, canals and/or pumps. Efficiency of design, soil suitability and social and economic feasibility have often been accorded lower priority. Monetary allocations for upgrading, maintenance and repair are much smaller and more piecemeal than budgets for initial construction and are therefore given less emphasis. Estimates for irrigation expansion potential given in the accompanying table therefore should be regarded as estimates of technical feasibility rather than overall socio-economic feasibility.

2.3 **Lao PDR Perspective**

2.3.1 *Irrigated & Irrigable Lands*

The pump-irrigated mainstream Mekong mainstream levees and flood banks between the Kading and Xe Bangfai confluences amounts to 4,400 ha in the wet season and 3,500 ha in the dry season (left and right bank areas). Water is pumped either directly from the mainstream or from small tributaries connected to the mainstream and influenced by its water level variations. The potential for expansion of irrigated areas has been estimated to almost a doubling for both the wet and dry season. The data available do not show, however, how much of this expansion would involve intrusion into ecologically sensitive wetlands. Diesel-

pumping has proven not economically viable; such expansion therefore would depend on rural electrification in these tracts.

In relation to potential effects on irrigated areas on the Pak Kading-Xe Bangfai reach, the water level changes due to NT2-HPP operation are expected to be relatively insignificant; the lower the water level in relation to the irrigation canal headworks, the more energy must be expended in lifting the water into the delivery system. Typical static heads in this tract range between 7 metres and 14 metres. While operation of the NT2-HPP will, in combination with Theun-Hinboun HPP (and its possible extensions), lower dry season river levels in the Pak Kading to Pak Hinboun Reach, the difference is relatively insignificant (7 cm in the dry season and 23 to 29 cm in the wet season). The lowering effect would be even less along the Pak Hinboun to Pak Bangfai Reach due to the operation of the Theun-Hinboun trans-basin diversion.

In the **20-year** scenario, employing Best Practices, a considerable part of what today is shifting cultivation area will have come under permanent cultivation of arable crops on terraces (on slopes below 25%), combined with smallholder-managed production of fruit trees and/or industrial tree plantations (with NTFP understoreys) on slopes up to 45%. Irrigation will be used, for both rice production and the production of supplementary forage for intensively raised stall-fed, large and small livestock. Natural forests in watershed protection areas (steeper than 45%) and NBCAs will have been regenerated, unproductive grasslands rehabilitated and production forests come under sustained yield management and registered with the Forest Stewardship Council (for further details of the visionary principles involved, see *ADRA, 2003*).

2.3.2 *Ongoing & Planned Irrigation Upgrading and Expansion*

Each provincial irrigation service has prepared plans and designs, some more sophisticated than others, for the expansion of irrigation infrastructure into all parts of the country where commandable land is still undeveloped. The last five years has seen a nation-wide programme of installation of pontoon-mounted diesel pumps (supported by the Government of India) on the mainstream and larger tributaries. Because of insufficient attention to canal and drainage networks, many of these schemes are proving uneconomic and replacement of diesel motors with electric motors is under way. Upgrading of canals and drainage systems is not yet planned in detail and is proceeding at a slower pace.

The ongoing World Bank Irrigated Agricultural Development Project (ADP) has been operating in four southern provinces of Lao PDR including Savannakhet and Khammuan, since 2001. As well as irrigation system upgrading, the project encompasses farm access roading, agricultural extension and micro-finance support for irrigators through strengthened Water User Groups.

2.4 **Local Perspective - NT2-HPP Proximal Impact Zones**

Those districts most directly to be impacted by the construction and operation of the NT2-HPP would be: Nakai, Nyommalat, Mahaxay, Xe Bangfai, Nong Bok, Hinboun, and Bualapha Districts of Khammuan Province; Khamkeut, Viengthong and Pak Kading Districts of Bolikhamxay Province and Xaibouly District of Savannakhet Province.

Because the most tangible impacts of a trans-basin diversion water-storage reservoir project are on hydrology and rural landuse, the present status of landuse is described for each main drainage basin in the proximal impact zone (Theun-Kading, Hinboun, Xe Bangfai) with reference to the catchment main component tributary. The NT2-HPP impacts would add to the hydrological,

environmental, ecological and economic impacts. Already attributable to the ongoing Theun-Hinboun Hydropower Scheme operations in addition to the residual pre-project "background" impacts attributable to logging, warfare and the unsustainable landuse practices of the indigenous communities. Reasons for unsustainability may be illegal (e.g. cultivation of narcotic crops), environmental (e.g. arable farming on acidic, unprotected slopes, ecological (e.g. over-exploitation of wildlife or NTFPs) or economic (e.g. exploitive logging). Even without the advent of hydropower projects, ongoing background impacts are identified as potentially requiring remediation under the Nation Environmental and Poverty Alleviation Action Plans. Some remediation will call for proactive intervention in the form of land development (irrigation, terracing, plantation, etc.) and of capacity building for stable landuse management. Accordingly, before inventorying present landuse in each catchment, the component Landuse Management Units (LMU) are identified as a basis for planning said interventions.

An LMU is defined as a tract of land, in which all sites have a commonality of "ownership" and "prime purpose". In this context, therefore, an NBCA is a tract of land "owned" and managed by the State for the prime purpose of wildlife conservation; a road corridor is "owned" by the State for the "prime purpose" of transportation. An irrigation scheme is "owned" (operated and managed) by the beneficiary farmers for the "prime purpose" of subsistence and cash crop production. A single LMU may occupy a part of two or more adjacent catchments.

The next step required will be to measure each LMU (using the GIS maps available in the MRC Database, augmented by aerial photo interpretation) and to quantify the pertinent social, physical and financial parameters, such as population density, land capability, rehabilitation if required, etc. This will lay the foundation for costing, scheduling and budgeting the necessary development and remediation interventions and for attributing the pertinent costs to the relevant stakeholders, including, but not confined to hydropower scheme operators.

Because of internal commonality of purpose, for future local and regional planning, it would be both possible and desirable to quantify for each LMU, such parameters as hydrological discharge regime, sustainable carrying capacity and sustainable agricultural and forest productivity. This would in turn allow for quantification and prioritisation of the investments needed to ensure sustainable achievement of international, regional and local environmental and social goals as embodied in the MRC's Basin Development Plan and Natural Resource Allocation Optimisation Model. Decision Support Framework (DSF) and Resource Allocation Optimisation Model (RAOM).

The Irrigated Agricultural Development Project (ADP) will construct four irrigation schemes in Khammuan. Details of location and size of ADP-supported irrigation schemes in Khammuan Province are shown below.

Table 5: ADP Planned Irrigation Schemes in Khammuan Province

Scheme Designation	District	Status	Service Area (ha)
Phandeng	Nyommalat	Bidding	100
Naphoxay	Nyommalat	Design	80
Thathot	Nyommalat	Design	280
Nakosin	Thakhek	Bidding	70
Sangom	Thakhek	Bidding	280
Total Service Area			810

Serious consideration should be given to extending this or similar projects throughout the Xe Bangfai Basin with prior emphasis on upgrading all existing projects to a "flood-proof" standard, complete with raised and gated primary, secondary and tertiary distribution canals and drainage systems. Canals should be aquaducted over natural waterways and fish-ways provided wherever necessary. Diesel pumps should be converted to electric power, with due consideration to network connection discipline and switchboard protection to prevent extensive motor burnouts due to phase-out or voltage drop conditions.

Expansion of this or similar irrigation-upgrading loan projects throughout the Theun-Hinboun catchment and Hai/Hinboun Basins is also to be recommended to augment the irrigation upgrading activities undertaken by THPC. The cost of upgrading (sometimes in excess of \$3,000/ha), goes far beyond what hydropower developers upstream should be expected to bear alone.

Stream flow regimes in the Theun-Kading, Hinboun and Xe Bangfai Basins and those reaches of the Mekong downstream from Pak Kading would all be affected by the construction and operation of the NT2-HPP. Accumulated hydrological impacts upon the Nam Kading and Hinboun Basins and the Mekong mainstream levees and floodplains downstream of Pak Kading arise from the daily operation of the Theun-Hinboun Power Scheme. Further hydrological impacts will arise if the Theun-Hinboun power station is expanded, if the proposed Phou Hai Pumped Storage Hydropower Scheme is constructed, or if storage reservoirs are built on the Nam Nyuang or Nam Phao (Nam Theun 3 sites), or the lower Kading (Nam Theun 1 site). Construction of any of these reservoirs would flood some potentially irrigable land and create a need to cater for farmers who would be inundated by said reservoirs. Irrigation development in the reservoir catchments also has a role to play in providing productive sedentary alternatives to shifting cultivation. This watershed protection initiative would enhance reservoir longevity through reduced sedimentation.

The Theun-Kading River system would suffer reduced flows as a result of the inter-basin transfer of water caused by the NT2 project, while the Xe Bangfai would receive the additional water. Currently enhanced stream flow in the Hai-Hinboun Basin would be reduced in the dry season until such time that the water-regulating reservoir is installed in the Nam Nyuang or Nam Phao (Nam Theun 3 site).

Table II - 3 gives an overview of the existing irrigation schemes and potential for expanding wet and dry season irrigation in the various basins. The information is sourced from MRC's database on irrigation in the Lower Mekong Basin.

Table 6: Existing Irrigated Land Potential Increase in the NT2 affected Catchments

Catchment	Existing Irrigated Rice (ha)		Potential Increase (ha)	
	WS	DS	WS	DS
Xe Bangfai	22,720	16,004	14,140	9,375
Nam Hinboun ¹	6,040	4,496	5,200	3,345
Lower Nam Theun ²	445	445	196	196
Nam Nyuang ³	128	90	-	-
Nam Phao/Nam Kata ³	1,475	1,248	1,309	1,109
Pak Kading – Xe Bangfai, riverine, Lao	4,789	3,706	4,045	3,174
Pak Kading – Savannakhet, riverine, Thai	15,885	-	-	-
Total	51,482	25,989	24,890	17,199

WS = wet season, DS = dry season

¹ Includes the reach above the confluence Nam Hai–Nam Hinboun

² Road 8, south of Nam Nyuang

³ Tributaries of Nam Theun

In the Xe Bangfai basin, a 62% increase in irrigated area appears to be possible for the wet season and 58% in the dry season.

Because of the considerable past investment in flood control and irrigation civil works in the lower Xe Bangfai, the GoL has designated it as a priority area for agricultural development. Whether this is a wise or environmentally sound decision, is debatable. Civil works include flood control levee banks (only partially completed), flood impoundment reservoirs, sluice gates, flood gates, etc. Numerous diesel and electric pump sets have been installed, but with insufficient attention to the commandability or efficiency of the irrigation distribution network; drainage provision is inadequate. The lower Xe Bangfai is an important flood reticulation wetland for the Mekong River system and also an important fish hatchery. It would appear preferable to desist from attempts to exclude floods, but rather to build "flood-proof" irrigation systems (such as those installed along the lower Nam Ngum with funding from the European Union). These allow the floods in and can then provide pumped water in the cool-dry season for supplementary irrigation of recession rice followed by a fully irrigated dry season non-rice cash crop.

The NT2 Social Development Plan describes the categorisation of the proximal impact area into fifteen zones of "activities and/or impact"; these will be denoted in the following text as ZAI-1 through ZAI-15.

2.4.1 *Theun-Kading Basin (14,822 sq km)*

The Theun-Kading Basin has a total catchment area of approximately 15,000 sq km (MRC Database). It incorporates territory of both Khammuan and Bolikhamxay Provinces as well as a portion of Mork Mai District in Xieng Khuang Province. It extends from the Lao-Vietnam border to its outlet at Pak Kading on the Mekong mainstream.

Out of up to four potential hydropower dams are envisaged for the Theun-Kading Basin, only one, the Theun-Hinboun Hydropower Scheme diversion dam has been constructed so far. This dam has a total catchment of some 8,700 km², which would be truncated to 4,717 km² if and when the NT2-HPP dam (catchment area 4,025 km²) is constructed at the downstream margin of the Nakai Plateau.

The total catchment area upstream of the Nam Theun 1 dam site near Pak Kading is about 13,700 km². This would effectively truncate to about 4,800 km², i.e. that portion downstream of the Theun-Hinboun diversion dam, if and when a new regulating reservoir (previously referred to as the Nam Theun 3 site) is constructed in the Nam Theun catchment. The truncated Nam Theun 1 catchment would, however, still benefit from riparian releases and flood overflows from the Theun-Hinboun dam.

When it reaches Sop Nyuang (Nyuang/Theun confluence) in the Theun-Hinboun headpond, the Theun river changes name to the Kading River. In practical terms, however, it is more convenient to consider the Nam Theun extending downstream as far as the Theun-Hinboun dam at Keng Bit. The upper reach of the Nam Theun is sourced at the Vietnam border and extends to the Keng Mao Gorge. The mid-Nam Theun reach extending from Keng Mao Gorge to the proposed NT2-HPP dam site at Sop Hia, while the lower Nam Theun extends from Sop Hia to TH-HPP Headpond.

Most likely, all of the irrigation potential along the Nam Theun and its tributaries have been developed in the 20-year perspective. Along Lower Nam Theun the total wet season irrigated area may have reached approximately 650 ha while total irrigated area along Nam Phao/Nam Kata may have increased to around 2800 ha. Development of all remaining potential irrigable land along the Nam Hinboun will bring the total area up to around 11,000 ha

In the event that all foreseen hydropower schemes are installed, discharge at the Kading/Mekong confluence would equate to:

- the total runoff from the entire Theun-Kading catchment, less evaporation from the NT1 reservoir, less
 - 1) trans-basin diversions to the Hinboun Basin via the expanded Theun-Hinboun Power Station, less
 - 2) evaporation from the Theun-Hinboun dam headpon,
 - 3) less evaporation from the proposed Theun-Hinboun Extension Storage reservoir, less
 - 4) evaporation from the NT2 reservoir, less
 - 5) trans-basin diversion to the Xe Bangfai Basin through the NT2 Power Station.

In terms of foreseeable hydropower development, the Theun-Kading Basin may be sub-divided into the four component catchments described below:

Prospective NT2-HPP Catchment (4,013 sq km)

Damming the Nam Theun near Sop Hia would impound the runoff from the entirety of the mid-Nam Theun and upper-Nam Theun catchments. The dam would be fitted with a multi-level outlet, to ensure that dry season riparian release does not contain eutrophic water and to allow for a mixture of hypolimnion waters with flood overflows to minimise the downstream pollution risk. Presumably, the dam will not be fitted with a sediment-flushing sluice gate as this could have severe effects on sedimentation in the Theun-Hinboun headpond. Table II - 4 depicts the present situation of irrigation on the Nakai Plateau tract.

Table 7: Existing & Potential Increase of Irrigated Land in the Nakai Plateau and Nakai-Nam Theun NBCA

Catchment	Existing Irrigated Rice (ha)		Potential Increase (ha)	
	WS	DS	WS	DS
Nakai-Nam Theun NBCA	155	10		20
Nakai Plateau	270	100		15

NB: Irrigated areas pertaining to 5 villages in the Nam Kata are included under Nam Phao/Nam Kata in Table II - 3 'Existing Irrigated Land Potential Increase in the NT2 affected Catchments'

From the managerial viewpoint, the proposed Nam Theun 2 reservoir catchment can be sub-divided into three component tracts as follows:

The Nakai Plateau (640 sq km)

The Nakai Plateau constitutes a critical Buffer Zone for the adjacent Nakai-Nam Theun NBCA. Numerous socio-economic and landuse surveys have shown that, due to warfare, logging and high population growth, the residents of the Plateau are living in poverty and under frequent threat from floods, and are continuing to degrade the natural resource base through their slash and burn agricultural practices.

The component tracts of the Nakai Plateau are described in detail below:

Potential Storage Reservoir Tract (450 sq km)

This will occupy the low-lying portions of the Nakai Plateau and it will comprise two zones: the permanent inundation zone (82 sq km) and the drawdown zone or intermittent inundation zone (368 sq km).

If the NT2-HPP proceeds, all irrigation existing schemes, excepting that at Nongboua, will be submerged by the reservoir although some recession rice may be possible in the dry season providing that wind-tolerant varieties can be introduced. The NT2 Resettlement Action Plan (RAP) calls for the installation of 200 ha of civil works for year-round irrigation of orchards, gardens, livestock forage and some rice. Water could be sourced from chains of gully-stop dams on small side-streams and by pumping from the reservoir and/or the Nam On.

Apart from the limited irrigated areas that presently exist, upland shifting cultivation and semi-permanent cultivation dominate agricultural practices.

Permanent Inundation Zone - This currently houses some twenty rural villages who will need to be resettled, but because of flood risk and high soil porosity, they do not make irrigated paddy fields in this tract. However, they do make temporary bucket-irrigated gardens in the dry season on the lower riverbanks and sand bars, producing vegetables, maize, sweet potatoes, tobacco, etc.

Drawdown Zone - Paddy fields have been established on the heavier soils on parts of this tract, producing cool-dry season rice, irrigated from gully-stops and seepages. Yields are low due to poor soil fertility, frequent high winds at flowering time and possibly varietal unsuitability. Even if the hydropower dam is built, the better soils in this tract have some potential for irrigated crop production during low water stages (e.g. rice, sorghum, forage crops) but variety trials, demonstration and agricultural extension campaigns would be required to achieve this. The sandier soils in the drawdown zone however, could become unproductive due to wave action.

Settlements/Resettlement Tract (208 sq km)

This elongated tract occupies the western rim of the Nakai Plateau between the Full Supply Level of the proposed reservoir and the Phou Ark Escarpment. It encompasses three villages (Nakai Tai, Nakai Neua, Nongboua Kham), only part of whose lands will be inundated. This tract also contains the Nakai District headquarters at Oudomsouk, two sawmills, a chipboard mill, the Ban Phon Phan Pek industrial resettlement village, Ban Nongboua pilot resettlement village, the Theun-Duane pilot resettlement farms and a tract of logged over forest designated for the agro-forestry resettlement of about 1,000 families. These are currently located in 21 villages along the mid-Nam Theun and would be completely inundated by the reservoir.

Piped irrigation systems have been installed by NTPC at the Theun-Duane pilot resettlement farms, the Nakai Neua Livelihood Training Centre and the Ban Nongboua pilot resettlement village. At Theun-Duane and Nakai Neua the water is pumped by diesel power from gully-stop dams and an ox-bow lake respectively. At Nongboua (which is connected to the rural electricity grid) water is pumped electrically from a large gully-stop dam. Crops irrigated are vegetables, forage crops and fruit trees.

The tract has been excised from the Nakai Plateau Protected Forest and State Production Forests to be allocated to providing a livelihood for reservoir inundatees. It is comprised of the following landuse categories:

- Nakai District town and the associated industrial zone
- Slash and burn and sedentary farmland of Nakai District town residents
- Shifting cultivation fields and bush fallows of some potential inundatees
- The Oudomsouk industrial worker's village erected by BPKP
- Trial plantations of pine and fast-growing Acacias, established by BPKP
- Pilot Resettlement Village established by NTPC, together with associated irrigation dam and irrigated farmlands
- The Theun Duane Pilot Resettlement Farms, established by NTPC in 1996/1997
- Logged-over Pine and Dry Evergreen Forest, both in need of rehabilitation.
Note: While the boundaries of the resettlement tract have been delineated on a map attached to the Prime Minister's Decree, there is still some dispute and confusion at ground level between the Nakai and Nyommalat District boundaries and to the access rights to the remaining timber in this zone. Air photo interpretation of Native Ecotype in 1998, combined with consultative village territorial boundary mapping produced the resettlement area layout map, which is still displayed on the wall of the NTPC Meeting Room in Vientiane. Native ecotypes depicted are:
 - Upper Dry Evergreen Forest: Indicates soils with some clay content, reasonable depth and cation exchange capacity - chosen for shifting cultivation by the local communities and suitable for sedentary agriculture. Suitable for rehabilitation as sustained yield village production forest, or on slopes less than 25%, for "self-building" terraces for resettlers gardens and arable croplands. Suitable for irrigated paddy fields in flat areas. Based on 1,000 families to be resettled, it was calculated that there would be enough suitable land in the resettlement tract to support a farm model comprising

- 0.2 ha of irrigated paddy field (to grow irrigated rice initially, but later when farmers gain confidence, to be converted to irrigated livestock forage production).
- 0.5 ha of irrigated home lot, approximately half of which (depending on family size) to be allocated to vegetables and fruit for family subsistence; the remainder for irrigated supplementary forage for cattle and/or buffalo kept overnight in a roofed stall at the bottom of the garden, equipped with roofed bins for composting the animal manure for application to the crop lands. Chickens, ducks and pigs were also housed in the animal enclosure. When the bovine diet is supplemented daily by 5-10 kg per head of high-protein, sweet green grass or legume, then the animals are enabled to consume and digest larger amounts of poor quality roughage from under the pine forests and in the draw-down zone, and to gain weight every day of the year. Good nutrition is the first step to good livestock health and high fecundity.
- ha of farm forest adjacent to the village site. Trials and demonstrations were initiated for sustained yield silvicultural management, domestication of non-timber forest products and introduction of phosphate fertilised forage grasses and legumes under mature pine trees.
- Mixed Deciduous and Bush Fallow Ecotypes: Future landuse as above.
- Pine Forests Ecotype: This is an indicator of infertile, sandy, highly erodable soils with compacted podzolic horizons and it is not recommendable for agricultural landuse. Severe erosion has occurred wherever logging tracks are aligned up or downhill and have not been provided with drains or culverts. Such land is suitable for rehabilitation as Village Production Forest but should be based on a mixture of slow-growing native species and fast-growing *Acacia mangium*, and possibly Eucalypts. Some areas require salvage logging due to the risk of wind throw where canopy gaps are too wide.
- Dry Dipterocarp Forest: Indicates shallow, lateritic, degraded soils, not suitable for agriculture, but can be rehabilitated for firewood and pole production by fire-protecting and installing contour bunds between the trees at 1-metre vertical intervals on sloping lands.
- Grassland: Clear areas of grassland in the resettlement tract comprise poor sandy soils underlain at shallow depth by bedrock (otherwise they would have been forested) and are unsuitable for any landuse other than very light grazing.

Resettlement site surveys determined where each village territory intersects the resettlement tract. There is sufficient land - Dry Evergreen or Mixed Deciduous Forest Ecotype - to cater for the irrigated home lots, orchards/gardens and croplands of each resettled village plus 0.2 hectares per family of irrigable paddy fields. Such land is in short supply however and village community facilities should be erected on land originally supporting Pine or Dry Dipterocarp forests. Irrigation will need to be brought to the farmland, rather than the farmland being located on unsuitable soil just to be conveniently close to pumping facilities.

The Margules Pöyry Report proposed a forestland allocation and management system based on the nucleus estates and smallholder's model used for tree cropping in Malaysia and Indonesia. Each farm family would be allocated a 3-hectare block of farm forest within the territorial boundaries of each relocated village, plus a share of the nucleus forest estate, which would lie at the south-western end of the resettlement tract, external to the territories of relocated

villages. It was recommended that the whole forest enterprise would be managed under a concession agreement with a private sector forestry concessionaire registered with the Forest Stewardship Council. The concessionaire would provide the planting materials and the professional staff to give the necessary instruction and guidance to the forest farmers (resettlers) managing the farm forest plots. The concessionaire would provide the processing and marketing facilities and give employment opportunities to resettlers in the silvicultural operations of the nucleus estate forest.

Experience in China since 1980 indicates that it is essential for the resettlers (who have no history of tight community organisation) to have individual ownership of the trees on their allocated lands. History is full of bad experiences with communal ownership of land and resources - the 'haves' in the community usually take advantage of the 'have-nots'.

The Theun Duane Pilot Resettlement Farms site was selected in 1996, through collaboration between NTEC, District Government, Sop On village elders and EcoLao. Site selection was based on convenient access to pumpable water (in the Theun Duane oxbow lake), soil suitability and elevation above the full supply level of the proposed reservoir. Farm layout was based on a tentative livelihood model that took into account the following considerations:

- When upgrading of the roads serving the construction and operation of the power station intake and dam is completed, the resettlement site, which is in the narrowest part of Lao PDR, will only be some two to three hours by truck away from the Thai border or the Vietnam border.
- With respect to neighbouring countries, Lao PDR is at a comparative economic advantage in exporting timber and non-timber forest products and large livestock. On the other hand, it is at a comparative disadvantage in the export of arable crops, vegetables and small livestock and local demand could be easily satiated.
- Experience with other irrigation and hydropower reservoirs in Asia indicates that fish yields are low, due to water pollution, in the early years and when yields do recover, fish capture falls into the hands of commercial entrepreneurs and monopolists rather than those of local residents. In addition, the reservoir will have a wind run of some 60 kilometres; wave action would therefore be severe and dangerous for small fishing boats. The reservoir will be wide and shallow, and therefore not suitable for "close-to-home" fish-cage culture. This is not to say that, given adequate precautions and good management, reservoir fishery could not eventually become an important part of the family livelihood model (perhaps replacing irrigated agriculture). For the tentative livelihood model, aquaculture was restricted to rearing frogs and fish in chains of gully-stop ponds (small earth dams erected across intermittent streams near the tentative village sites). NTEC undertook to install and operate (for the period of the BOT period) electrically pumped water systems for domestic supply and irrigation for gardens, orchards, livestock forage and rice fields.
- With ongoing population growth in rural Southeast Asia, the continued husbandry of large herds of extensively grazed bovines is not a sustainable option, in either the resettlement area, or anywhere else. Southeast Asian grasslands are invariably the result of forest degradation and are poor in productive capability; they are usually burnt in the dry season, with resultant damage to the forest on their verges. Grazing animals under forests is detrimental to forest regrowth. Many of the buffalo herds on the Nakai Plateau do not belong to local residents but belong to the military or lowland

farmers in neighbouring districts. Experience shows that conversion to intensive cut-and-carry livestock husbandry systems is the only sustainable option. The tentative livelihood model therefore included provision for the irrigated plantation of Napier Grass and experimentation with ponded pastures to be planted in the reservoir drawdown zone. Three or four well-fed and well-medicated bovines per family can produce more income than ten or more extensively grazed large ruminants, which tend to lose weight and fertility in the dry season, due to poor forage quality. They are also prone to attack by tigers.

The monitoring system (labour inputs, crop yields, etc.) was designed in collaboration with an Agricultural Crops and Livestock Consultant hired by the World Bank. NTEC staff were trained in operation of the monitoring system and took responsibility for its execution. The original plan for the pilot resettlement farms called for relocation of ten volunteer families from Sop On Village to Theun Duane; only three families were installed before the Thai financial crisis caused NTEC to withdraw all but "caretaker" support to the activities at Theun Duane. Severe budgetary restrictions were imposed and plans to collaborate with the "Forages for Smallholders Project" (for trialling ponded pasture and introduction of other forages for under-forest and drawdown zone grazing) and the Lao-IRRI programme (for selecting and trialling wind-tolerant irrigated rice varieties) were shelved. In addition, plans for monitoring the labour requirements for silvicultural management of the farm forests were not approved. Training of villagers and collaboration with the schoolchildren at Nakai Neua was suspended. Irrigation water supply was limited to house garden requirements only so that demonstrations of irrigated forage production did not proceed.

It was not until early 2004 that further land was prepared to receive more families from Ban Sop On. Old lessons about the need for selecting suitable soils and developing terraces by the labour-intensive "self-build" method were forgotten. The terraces were installed mechanically and improperly levelled and will require considerable soil rehabilitation before they become productive. Monitoring the performance of only three families cannot be considered statistically relevant, but the findings are no less indicative. Salient findings are: although rice is the preferred staple, cassava is far more productive and is normally grown by the local communities, who also produce maize, sweet potato, taro and yams as supplementary staples. Establishing the houses on the home lots provides salutary advantages in labour efficiency. The home lots were weed-free at handover and have been maintained weed-free ever since. While the men are out working in the farms and forests, collecting livestock forage, firewood, etc., the women can much more combine cooking and childcare with tending the small livestock and gardens when the house lots are built on farm, rather than on a central village. The design of the pilot village did not take this consideration into account. Note: the more recently established Pilot Village is near Nakai District town, whereas the originally established pilot farms are located seven kilometres away in Sop On village territory.

There is plentiful family labour available to care for 0.2 ha of irrigated paddy field, 0.5 ha of irrigated orchard garden forage plot, 3 ha of farm forest and still undertake animal care and off-farm work. It is therefore recommendable to expand the size of the irrigated home plot to at least 0.75 ha.

In summary, the tentative livelihood model provided for the following:

- About half the family's rice needs of 0.2 ha of irrigated paddy (2 crops per year).

- All of the family's fruit and vegetable needs, plus some maize and sorghum for supplementing the diet of domestic pigs and poultry for domestic consumption, supplemented by fish - some caught in gully-stop ponds constructed across intermittent stream beds and, possibly from reservoir access canals dug from village boat landings to bring in water from the reservoir from at least average operating level.
- Large livestock fed on supplementary irrigated grass and grazed in the draw-down zone in the dry season and in the forest verges in the wet season - some consumed and some sold to the lowlands in exchange for rice, or for cash to buy rice, enough to meet production deficits.
- Legalised sale of timber from 3 ha per family of farm forest - capable of a sustained yield of 4.5 m³ of timber, netting an annual cash income of about US \$300 per family, after deduction of royalties in order to cover costs of medication, recreation and education; to make savings and to pay other governmental taxes. Farm forests, predominantly pine, were to be located close to the villages. In the case where these pine forests are under stocked (chiefly due to previous logging), they were to be enrichment planted with pines or other fast-growing species, or a mixture thereof, with the villagers financed by cash wages and/or food-for-work, sufficient to make up the forestry income per family to \$300 per annum.
- Firewood supplies from the Dry Dipterocarp component of the Community Forest and up to 1 m³ per annum of hardwood timber from the Dry Evergreen component of Community Forest for house and fence repairs, furniture, etc.

For statistical relevance, further development of the "original" model as described above would have required the addition of at least seven more families to the Theun Duane settlement. This did not transpire, due to a cost minimisation stance adopted by NTEC, due to the Southeast Asian economic crisis. When, several years later the refinement of the RAP commenced, there had been a change in personnel and activities concentrated on Nongboua Village rather than Theun Duane. One very important recommendation that has become evident is that, due to the thin soils in the resettlement tract, all soil-erosion control and land development works should be performed by hand labour as mechanical earth-moving exposes too much infertile and erodable subsoil.

The Nakai-Nam Theun NBCA (NNT NBCA - 3,363 sq km)

Damming the Nam Theun near Sop Hia would impound the runoff from the entirety of the mid-Nam Theun and upper-Nam Theun catchments.

The NNT NBCA encompasses the catchments of the Nam Xot, Nam Mon, upper Nam Theun, Nam Noy and Nam On tributaries of the Nam Theun. Population density is less than five persons per sq km and the whole tract has been gazetted for biodiversity conservation.

On the upper Nam Theun and its tributaries in the NNT NBCA, a number of small irrigation schemes have been constructed to serve the enclave villages (see Table II - 3 above). Possibilities for further expansion are severely limited by rough topography and deeply incised streambeds.

Route 8B from the bridge at Ban Thalung to Lak Xao follows more or less the northern boundary of the NBCA. A dry season only logging road (previously used mainly for NTFP extraction) extends from Lak Xao to Ban Navang, paralleling the Lao Vietnam border. Otherwise, access is by foot (3 days walk from villages near the border to the Nakai district town). Although constrained by cataracts, the main tributaries are navigable for at least some months of each year.

To cater for the construction traffic it will be necessary to upgrade, not only the road from Thakhek to Nakai via Mahaxay and Nyommalat, but also the logging trails between Nakai and the Sop Hia dam site and to construct a road from the dam site to the quarry in Bolikhamxai Province. These latter roads will cross the Protected Area Corridors between the Nakai-Nam Theun NBCA and the Khammuan Limestone and Nam Kading NBCAs. To minimise the impact on wildlife migration, it is recommendable to split these roads into two separate narrow single-lane thoroughfares with trees meeting overhead wherever possible. Wildlife Ranger Checkpoints should be located on roadsides at strategic points. Given that Routes 8, 9 and 12, joining the Mekong Valley to Vietnam, are now all being upgraded, it would be preferable from the wildlife conservation viewpoint, to disable rather than upgrade the logging route from Ban Thalang to Lak Xao. In 1998, the World Bank interceded with BPKP to cancel plans to extend a logging road to Ban Navang in the Upper Nam Xot sub-catchment. The Panel of Experts (POE) and the World Bank International Advisory Group (IAG) also subsequently strongly recommended that any access development in the Nakai-Nam Theun NBCA should be restricted to blasting gorges for easier small boat access and widening walking tracks to permit the passage of 2-wheel hand tractors and trailers, but not logging trucks.

Enclaved Village Territories.

There are several ethnic minority communities enclaved within the boundaries of the NBCA, practising hunting and gathering, and shifting cultivation, together with paddy field irrigation in those few riverine tracts of flat land scattered throughout this tract. There is some potential for enhanced dry season cropping by pumping, both for existing paddy fields and for terraces to be developed on sloping riverbanks above flood level. Local enclave residents constitute little threat to the integrity of the NBCA biodiversity when compared to the incursions of wildlife traders and hunters and gatherers from across the Lao-Vietnam border, where the population density is much higher and natural resource degradation much more advanced.

The enclaved communities in the NNT NBCA comprise thirteen villages in the upper Nam Noy, nine villages along the upper Nam Theun and nine along the upper Nam Xot. Since 2001, the Watershed Protection Management Authority (WPMA) has been coordinating the implementation of community development and wildlife protection activities funded from various sources, including the World Bank and the Government of Japan. Ongoing activities include the construction of schools, the training of formal and non-formal teachers, health and sanitation upgrading, wildlife-management awareness training and patrolling. Firearms have been confiscated and it is reported that a significant increase in wildlife population is observable.

There is kinship solidarity between ethnic minority villagers on both sides of the border however and reportedly, the awareness-raising activities supported by the WPMA have reduced cross-border incursions and helped restore wildlife population numbers on the Lao side of the border. Since 1996, the NT2-HPP Panel of Experts and the World Bank International Advisory Group have been conducting field excursions and making recommendations on linking the WMPA with biodiversity protection measures on the Vietnamese side of the border under the auspices of the Lao-Vietnam Border Coordination Committee, with the ultimate prospect of establishing the Annamite Ranges World Heritage under the auspices of UNESCO. Very little has happened in practice, apart from the establishment of the WPMA, which is still skeletal in nature, under-funded and definitely not equipped to address cross-border issues or the integrity of the chain of associated Protected Areas, gazetted or proposed, along the Annamite Range.

The Nam Theun 2 Concession Agreement made provision for allotting a budget of One million US Dollars per annum for supporting NBCA development and management, including irrigation upgrading. This is an estimate, thrown into the ring during concession negotiations; it does not appear to be based on any professional assessment of NBCA management needs, nor is it linked to the potential revenues from electricity sales. One to two percent of annual revenues is the generally accepted norm for financing the integrity of hydropower catchments and the long-term welfare of the residents. It is quite unlikely that NTPC could provide significant financial support for the Nakai-Nam Theun NBCA until at least financial closure and possibly, until the revenue stream commences. TH-HPP has been utilising water from the NNT-NBCA since 1998 and, whilst it pays taxes directly to the Khamkeut and Hinboun District governance, it does not make any direct contribution to upper catchment protection, land development or wildlife protection, except in those cases of families directly impacted by headpond flooding.

Truncated Theun-Hinboun HPP Catchment (4,717 sq km)

Particular attention is drawn to the rural community and land development activities of the Theun-Hinboun Power Company with over 300 families impacted by filling the diversion dam headpond. Although no involuntary resettlement is involved in Theun-Hinboun, the compensatory activities and the results thereof will have high relevance to the resettlement situation that will eventuate in the NT2 Project Areas on the Nakai Plateau.

Major tributaries of the Theun-Hinboun diversion headpond are the Nam Nyuang, Nam Phao/Kata, the lower Nam Theun, Nam Ngoy and the Nam Ao. There is a topographic limitation to further extension of flood-irrigated paddy field area. There is some opportunity, however, for the extension of garden/orchard irrigation on river levees as has been done by the THPC, to compensate loss of stream bank orchards and gardens from inundation by the headpond and the downstream discharge.

In the Nam Phao and Nam Nyuang catchments upstream of the headpond, the only agency giving attention to the socio-economic plight of the inhabitants of the catchment is the Wildlife Conservation Society (WCS). WCS is soon to commence a participatory wildlife management programme in some parts of the catchments as a means of raising buffer zone communities' incomes through sustainable wildlife harvests whilst helping to conserve the integrity of the Nam Kading, Khammuan Limestone and Nakai-Nam Theun NBCAs.

History shows that allowing swidden fallow periods to reduce and permanent cultivation to occur on steep slopes, without land development and soil conservation interventions, would result in irreversible degradation of the soil and the ecosystem, followed by abandonment of the land and unproductive, annually burnt grasslands. This situation is already evident in some highland areas designated as NBCAs and is causing weed infestation problems in sedentary farmlands around the Theun-Hinboun headpond.

Possibly, up to fifty percent of the potential area for irrigation expansion will have been utilised along the Nam Theun tributaries within 5 years, amounting to 600-700 ha.

Parts of this catchment are occupied by various NBCA Core Zones, but to date, apart from financing some signposting and nature trail mapping, neither THPC, nor any other agency is making any significant financial contribution to their protection and management. The Wildlife Conservation Society (WCS) will, however, be managing a five-year Wildlife Conservation Management Programme, funded by the Global Environmental Facility (GEF) through the

World Bank. Without however, parallel funding for agricultural sedentarisation and poverty alleviation, commencing with irrigation system development, across the Lao Vietnam border, then the effective protection and conservation of natural biodiversity in these sanctuaries cannot be expected. THPC has made significant progress with agricultural sedentarisation for the 300 families impacted by the headpond inundation zone as part of its environmental and social mitigation and compensation programme. It is not, however, likely to embark upon NTFP domestication or the incorporation of forestry into farm family cash flows, which would be necessary to guarantee sustainable livelihoods.

If the THPC proceeds with its proposed extension and expansion of generation capacity, it will require to find a suitable site for development for resettlement of the families who would be inundated by the new reservoir, preferably within the catchment, because of a shortage of suitable land elsewhere. According to ADB Operational Guidelines, an offset forest regeneration area should be delineated and protected, equivalent in area to each of the ecotypes to be flooded by the hydropower reservoir impoundment. As there is no scope for it within the proposed NT2 catchments, the Theun-Hinboun Catchment is the first choice for this "offset" forest. An offset reforestation area would presumably be required also to compensate for forest inundated by the Theun-Hinboun Extension Reservoir. This would also need to be located in the Theun-Hinboun Scheme catchment or the Nam Theun 1 Scheme catchment. Preferably, it would be combined with an agro-forestry sedentarisation programme, bringing current swidden bush fallows under reforestation with a mixture of fast-growing industrial species and slower growing natural species, with the local communities participating in management and a portion of the harvest. The constituent tracts of the TH-HPP catchment are described below:

Theun-Hinboun Hydropower Scheme Catchment (9,075 sq km)

The headpond of the Theun-Hinboun diversion dam is supplied by three major tributaries: the Nyuang, the Phao and the Theun. Downstream discharges into the Kading from the dam at Kengbit supply the totality of the runoff from the three constituent sub-catchments, less evaporation from the headpond, less diversions by tunnel to the Theun-Hinboun power station in the Hai-Hinboun Basin (up to 110 m³/s). If, and when, the planned power station expansion is installed, peak diversion discharge will increase to 220 m³/s. Engineering and economic feasibility investigations are in hand for siting a dam on the Nam Nyuang or Nam Phao for storing wet season runoff to augment dry season power generation. Some ten or more sites are undergoing comparative geological analysis. This enhanced cross season storage would augment THPC's dry season power generation capacity, as the existing headpond is only large enough for daily buffering. It would also help compensate for the considerably reduced discharge of the Nam Theun tributary if and when the NT2 hydropower scheme dam is constructed at Sop Hia. To enhance the water storage in the potential Nam Phao reservoir site, a diversion from the Nam Theun is under consideration. There are many rural villages in the Nyuang and Phao Valley catchments, but few along the lower Nam Theun. The residents are of Tai or Vietic ethnicity preferring riverside locations, but there are also some Hmong communities who prefer ridge-top locations. Navigability is restricted by cataracts in many reaches. Route 8 links the Mekong Valley with Vietnam, crossing the Nam Theun by bridge at Tha Bak; it proceeds through Lak Xao (the capital of Khamkeut District) en route to the border post at the Kaew Neua Pass. Route 8 is sealed and is currently being upgraded with grant assistance from the Swedish government. There are several branch roads into both the Nam Nyuang and Nam Phao catchments.

The Theun-Hinboun headpond inundated the temporary dry season streambed and lower bank gardens of several riverside villages. THPC has made compensation in rice for immediate loss of income, has supported the establishment of new bank-top pump-irrigated and rainfed gardens, orchards and rice fields. Apart from assistance with land development and titling, the company has supported the installation of potable water supplies, sanitary toilets, micro-finance revolving funds and enhanced livestock breeds, together with nutrition and veterinary services. Riverside bathing platforms and boat landings have been augmented. Road access and electricity supply have been upgraded hand-in-hand with local government. The Theun-Hinboun headpond is silting up quite rapidly. This will most likely be exacerbated by the “hungry” water erosion from the riverbanks downstream of the Nam Nyuang or Nam Phao regulating dams (previously known as Nam Theun 3) and the Nam Theun 2 dams. Regulation afforded by the Nam Nyuang or Nam Phao dams would help offset the loss of buffering capacity of the Theun-Hinboun headpond caused by damming the Nam Theun for the NT2 hydropower scheme.

Nam Phao Catchment

Mountainous Headwater Tracts. These encompass the gazetted and prospective NBCAs and PPAs that comprise the northeastern corner of the NNT NBCA and its northern extension (renamed Bolikhamxay Highlands NBCA). Many of the higher slopes have been degraded by pioneer shifting cultivation production of maize and opium poppy; the resulting unproductive grasslands are burnt annually, and require fire protection and forest regeneration.

Lands of slope < 5%. Most of these are already devoted mostly to some form of paddy field irrigation although there is considerable potential for upgrading. In the 1980s, BPKP mounted a resettlement programme by developing rice fields along the ex-Ho Chi Minh Trail, running towards Nakai and providing a pumped and piped irrigation system for the resettled Hmong ethnic group. The pumping system eventually failed and many more families migrated to slash and burn the steep forest further down the Nam Phao and up into the Nam Kata Valley, making frequent hunting and gathering forays into the nearby Nakai-Nam Theun NBCA, in which they were forbidden by the Khammuan provincial authorities to locate their residences.

Hilly and Mountainous Lands. Most of the remaining tall-growth forests have been logged to a greater or lesser extent. Much of the forest has been converted to cyclic re-occupance shifting cultivation. Once agriculture has been sedentarised (by irrigation development, terracing and pasture improvement), there is considerable potential for fast-growing orchard and industrial tree plantations (with community involvement), in this tract - particularly with respect to its proximity to National Highway Route 8 Corridor (Tha Bak to Lak Xao).

Lower Nam Theun Catchment

Wildlife Corridor A wildlife corridor crosses the Nam Theun just upstream of the proposed NT2-HPP dam site, joining the NNT NBCA and Khammuan Limestone (Phou Hin Poun) NBCA, allowing the migration of wildlife (including elephants) between the two.

Hilly & Mountainous Tracts Downstream of the NT2 dam site, the terrain is mainly steep and mountainous, consisting largely of MRC Watershed Class 2 land. There is virtually no irrigation and no commercial logging in these hilly and mountainous tracts due to the lack of settlements and steep, inhospitable topography.

Nam Ngoy Catchment

Hill Tracts

There has been little commercial logging because of the very steep topography but there has been considerable lumbering of valuable species such as Eaglewood and Ebony by the communities settled in the valley bottom. Hills near the villages are subjected to shifting cultivation of upland rice.

Settled Tracts

As the narrow valley bottoms have already been settled and used for paddy field irrigation, there is little potential to expand irrigation in this catchment.

Nam Kading NBCA

The southernmost portion of this NBCA extends to the Nam Hai and other, lesser Hinboun tributaries, such as the Nam Sanam and Nam Mahoy.

Nam Nyuang Catchment.

The Nam Chuan and Bolikhamxay Highlands NBCAs.

These NBCAs cover the high altitude western slopes of the Annamite Ranges. Parts have been degraded by opium cultivation and abandonment to annually burnt grasslands. Steep and eroding logging roads have been built into this area for the extraction of the valuable *Fokienia (Mai Long Leng)*, some of the trees being 300 years old.

Pha Khadoung Saola Management Area.

This tract comprises about 700 square kilometres and incorporates a predominantly forested area in the valley of the Nam Nyuang at an altitude between 450 m and 1,500 m (to incorporate the Saola's usual range of 500m to 1,000 m). It has been identified, but not as yet gazetted. The main objective is to provide a habitat for conserving the rare Saola antelope (bovid species, *Pseudoryx nghetinhensis*). The Saola (discovered only in 1992) is a very ancient species of spiral-horned bovid, whose diet is restricted to a very narrow range of plants found only alongside small streams in the moist evergreen rain forests of the Annamite Range in central Lao PDR and Vietnam.

Dependent upon the location chosen for the regulating reservoir for the Theun-Hinboun Hydropower Scheme extension, a smaller or larger portion of the proposed Saola Management Area may become inundated. In the application of Best Practices, rather than being an adverse impact, this inundation could lead the way to positive benefits, provided that THPC, or other, are prepared to devote funds and expertise to the proactive management of the biodiversity integrity of this tract.

Sedentary Agricultural Tracts.

Numerous village communities have developed sedentary gardens and some paddy fields along the narrow streamside tracts. Some could be developed for irrigation although pumping would be necessary due to the high riverbanks. High floods damage crops on this tract once every ten years or so.

Other Hilly Tracts.

Virtually no primary forest remains because of extensive shifting cultivation. Soils are quite good however and the area has high potential for fast-growing industrial tree crops production, recommendably on the nucleus estate and smallholders principle (see notes on the Mekong Minor Tributaries Tract and Nam Thon Catchment). As part of its environmental and social impact mitigation and compensation programme, THPC has installed piped, pumped irrigation systems

for orchards and gardens, in villages impacted by the headpond, together with sponsoring of soil-erosion protected rainfed agriculture on lands of slope less than 25%. This serves as a useful pattern and demonstration for future resettlement activities in the Theun-Kading Basin. An area at Ban Tha Si has been identified as having possibilities for resettlement from the proposed Theun-Hinboun Extension reservoir. It may also have capacity for development as a resettlement site for the proposed Nam Theun 1 Hydropower Scheme, but this requires further collaborative investigation.

Headpond Tract

As for "Other Hilly Tracts" above.

Nam Ao Catchment

Nam Kading NBCA.: Although the Nam Ao mainstream parallels the NBCA, its right bank tributaries drain from the high ridge that forms its eastern boundary.

Sedentary Agricultural Tracts.

The most significant of these tracts is around Ban Na Di, where considerable small stream irrigated paddy fields have been developed.

Extensive Agriculture Hill Tracts.

As for most other parts of the Theun-Hinboun catchment, little primary forest remains but considerable potential exists for fast-growing tree crop plantations. The Nam Ao River could be used for transport of logs to the Theun-Hinboun headpond, where they could be lifted out and loaded onto trucks, utilising the dam access road and Route 8.

Truncated Prospective Nam Theun 1 Hydropower Scheme Catchment (5,069 sq km)

A pre-feasibility study for this scheme was performed by the consultants, Electrowatt-Ekono, for a potential developer from Thailand some ten years ago, but was shelved partly as a result of the southeast Asian economic crisis. The feasibility study is now being revised by the same consultants hired by a Malaysian civil engineering and construction firm having potential financial support from the Malaysian Government. The various social, environmental and economic effects of alternative dam heights are being investigated, including a possibility of pumped storage of Mekong floodwaters. Current discharge at the dam site is the total runoff from the Nam Muan catchment, plus the runoff from that part of the Upper Kading catchment that lies downstream of the THPC diversion dam at Kengbit, plus the riparian release (5 m³/s), flood overflows and sediment-flushing discharges from said dam.

The catchment is occupied by about 60 villages and Viengthong, the district centre. This town is accessed from the dam site by a walking trail following the Kading, Muan and Ngom riverbanks (2 days walk). A dry weather only logging road, destined as National Route 1, links Viengthong with Meuang Mok in the North and with Tha Bak on National Route 8 to the South. The northern route fords the Nam Muan and the southern route crosses the Nam Nyuang branch of the Theun-Hinboun headpond by motorised ferry. The navigability of streams and rivers is impeded by numerous cataracts.

Along the Nam Kading, no significant irrigated areas are found and there is no significant potential for providing infrastructure to any land for irrigation. Most of the area along Nam Kading consists of forest of varying density and forest mosaic and shrub land. There is little agricultural activity apart from scattered patches of shifting cultivation

In the **5-year** Scenario, agriculture will still be dominated by shifting cultivation but the fallow period will have been narrowed down to 3-4 years in some areas while it will be nearing permanent cultivation in others.

Nam Muan Catchment

The Catchment comprises:

- Nam Chouan NBCA: Western slopes of the Annamite Ranges (see previous notes)
- Nam Kading NBCA: This comprises a large part of the catchment downstream of the Nam Nyuang confluence and the THPC diversion dam. Some of this NBCA would be flooded if the Nam Theun 1 Dam is built.
- Intensive sedentary agriculture tracts: Most of these are associated with the settlements in the main Nam Ngom and Nam Muan catchments. Some irrigated paddy fields have been developed along small tributaries.
- Shifting Cultivation Hill Tracts: The situation is similar to that in the Nam Nyuang catchment.

Lower Kading Mainstream Catchment

Extending from the Kading-Mekong confluence upstream some 35 km to the potential Nam Theun 1 dam site (located at the gorge where the Kading emerges from the hills onto the Mekong floodplain). Route 13 South, linking Vientiane with Pakxe crosses the Nam Kading within sight of its confluence with the Mekong. Otherwise, access within the catchment is by walking trail or by boat as far as the Nam Theun 1 dam site. Some previously riverside villages have recently moved to re-establish alongside the highway.

Only some limited existing irrigated areas with potential for expansion are found along the tributaries that join the Nam Kading close to its confluence with the Mekong. Small diversion weirs may be feasible for some of these, but most would require the installation of pumps.

To compensate for a lower dry season water table, the THPC has provided potable water systems to those 10 or so villages in the Lower Kading Catchment, which are situated on the riverbank.

Stream flow at the confluence comprises of the runoff from the entire Theun-Kading Basin less what is diverted into the Hinboun Basin through the Theun-Hinboun Power Station, less what is evaporated from the Theun-Hinboun headpond.

The component tracts of the Lower Kading Catchment include:

1) Nam Kading NBCA, 2) Nam Pang Catchment (including a military reserve), 3) Nam San Catchment, 4) Say Phou Ngou Provincial Protected Area, 5) Route 13 South Highway & Residential Corridor, 6) Sedentarised Flatlands, 7) Rolling Shifting Cultivation Lands.

Nam Theun 2 HPP Proximal Impact Zones

Many of the landuse practices in these tracts, especially in the hilly areas, are unsustainable, leading to soil erosion and ecological degradation. They risk becoming more so, as population continues to grow unrestricted, but without the appropriate poverty alleviation or land and community development measures being implemented. As a basis for planning the "Best Practices" restorative measures to be implemented following the MRC Basin Development Plan (BDP),

the various component tracts of each sub-basin are described under the headings according to the landuse management classification, which combines consideration of topography, land capability, population density, present landuse, conservation priorities, priorities for industrial and infrastructural development. Quantification is provided insofar as the available data permits but final quantification must await the refinement and augmentation of the data on hand.

In the late 1970's, the precursor of the Mekong River Commission identified the engineering possibilities of producing hydropower by trans-basin diversion with a reservoir on the Nakai Plateau. In 1985, the Snowy Mountains Engineering Corporation (SMEC) commenced geological and hydrological feasibility studies for what became known as the Nam Theun 2 Hydropower Project (Nam Theun 1 is a proposed site near Park Kading; the present Theun-Hinboun Scheme was known for a time as Nam Theun 1/2 and the proposed Nam Theun 3 dam site is on the head waters of the Nam Nyuang, north of Lak Xao). By the early 1990's, technical, preliminary engineering, hydrologic and economic feasibility studies had been completed and a Memorandum of Understanding signed between the Government of Lao PDR (GoL) and the Nam Theun Electricity Consortium (NTEC, now NTPC), headed by Transfield of Australia and incorporating Thai construction and finance companies and Électricité du France.

By the mid-1990's, NTEC had established offices in Vientiane and Thakhek, made a financial contribution towards the extension of the national electricity grid from Thakhek through Nyommalat and up the escarpment to Nakai District town, established a quarry and crusher between Nyommalat and Mahaxay and upgraded the road from Thakhek to Nakai. In 1994, NTEC hired TEAM Consultants from Thailand, who conducted a detailed census of families, livestock, building, orchards, etc. Of the twenty or so villages to be inundated by the Nam Theun 2 Reservoir; some alternative resettlement sites were also identified. By 1995, NTEC had been able to arrange financing and insurance for everything except Sovereign Risk (i.e., private sector protection against nationalisation). NTEC made application for Sovereign Risk coverage to the World Bank in 1995. A large multi-disciplinary World Bank mission was subsequently mounted, which pointed out to NTEC that the Project Action Plan was out of line with emerging World Bank Operational Procedures concerning project-affected people and the environment in many aspects. Particular concern was expressed about the following aspects:

- Lao PDR had no national resettlement policies and NTEC did not have cogent resettlement plan indicating how resettlers livelihood and welfare would be guaranteed after relocation,
- As per the Tropical Forest Action Plan (prepared in 1989 with Swedish Government support and with technical assistance from IUCN), the Forestry Department had declared the headwaters of the catchment of the Nam Theun as a National Biodiversity Conservation Area since the early 1990s. Much concern was expressed that logging of the potential reservoir inundation area was also extending into the NBCA forests. In fact, significant inroads had been made into these flatland forests, lying between the potential inundation area and the edge of the Phou Ark Escarpment.
- The potential impact on fisheries of damming the Nam Theun River had not been assessed, nor had the potential environmental and social impact of releasing large volumes of turbinated water through the trans-basin diversion into the valley of the Xe Bangfai River.

NTEC responded by taking the following actions:

- Contracted an NGO (CARE International) to conduct baseline socio-economic surveys of the potentially inundated communities.
- Contracted the Golden Valley Timber Company to review the resettlement site alternatives identified by TEAM Consultants and to draft tentative livelihood models for resettlers.
- Supported the establishment of a Resettlement Management Committee, comprising of officials from Khammuan Provincial and Nakai and Nyommalat District governments.
- Co-opted a senior Ministry of Agriculture and Forestry official to draft a Nam Theun Resettlement Policy as a component of a National Resettlement Policy.
- Contracted Dr. Maurice Kottelat to survey and record the fish biodiversity in the Theun Kading Basin.
- Contracted the Forestry Consultants, Margules, Groome, Pöyry to survey and install markers along the approximate perimeter of the proposed reservoir as a basis for confining logging to below the potential full-supply level.
- Provided a vehicle and per diem for a central government officer to regularly patrol the designated reservoir boundaries and apprehend any logs taken from above the potential waterline.
- Supported the Forestry Department in establishing checkpoints for monitoring log and wildlife traffic at Nakai District town and on the Nakai-Lak Xao road, where it crosses the border between Khammuan and Bolikhamxay Provinces.

2.4.2 *Nam Hinboun Basin*

Particular attention is drawn to both the social, economic and environmental impacts associated with the operation of the THPC Power Station, also to the mitigatory activities that have been implemented. In many respects, the impacts on the Hinboun Valley represent a microcosm of the impacts to be expected from trans-basin diversion of Nam Theun waters into the Xe Bangfai.

The Nam Hinboun basin, which also includes areas upstream of the confluence of Nam Hai and Nam Hinboun, has potential for 86% and 74% for wet and dry season irrigation area expansion respectively. However, due to regular flooding, irrigation schemes in the lower reaches of Nam Hai and Nam Hinboun are vulnerable to long periods of high water.

The daily fluctuating discharge of turbinated water from the powerhouse, inadequately regulated by a non-dredged surge pond, has led to severe erosion along the 14-km course of the Nam Hai through mass wastage and widening of the meander belt. The flooding of stream bank gardens without compensation for four years, led to compensatory increased illegal clearing of forest for shifting cultivation on steep slopes with a consequent increase in rainfall runoff and topsoil erosion.

Due to a restricting gorge and Mekong mainstream flood backup however, irrigated rice fields in the Hai-Hinboun Basin are subject to severe flooding two to three years out of ten. Flooding for three days does not harm the rice crop, provided that there is little current or sediment deposition. Flooding from three to seven days depresses the harvest yield and flooding for more than seven days kills the crop. To compensate, farmers keep "flood-proof" farm animals such as buffalo and ducks and harvest considerable quantities of fish, frogs and other aquatic animals from the flooded paddy fields.

If expansion of the THPC's generating capacity were accompanied by provision for gravity irrigation in the Hai-Hinboun Plain, this could have considerable socio-economic impact on the resident communities by relieving them of the necessity for paying the cost of pumping. This would have the knock-on effect of reducing use-pressure on the bio-genetic resources in the adjacent Khammuan Limestone and Nam Kading NBCAs and also:

- Increased stream flows and river levels in the Nam Hai and Nam Hinboun, with severe and fluctuating increase in the Nam Hai;
- Have negligible effects on the flood levels in either the Nam Hinboun or Nam Kading;
- Dilute the toxic mining wastes and sediments discharged into the lower Nam Hinboun from hydraulic mining in the Nam Pathen Valley;
- Impede navigation in the Nam Hai and mid-Hinboun due to trees and tree stumps being undermined by stream bank mass wastage in the Nam Hai and falling into the river.
- Similarly for the Nam Hinboun where deep pools have been filled with coarse sediment, water is discoloured by fine sediment eroded from the banks of the Hinboun and particularly from the Nam Hai. Enhanced fish catches have been observed in the Hai-Hinboun Basins, possibly due to turbinated water raising overall river volume with nutrient-rich sediments from the Nam Theun and its tributaries, mixed with suspended soil particles eroded from the banks of the Nam Hai.

Along the whole length of the Nam Hinboun, present irrigated areas amount to around 6,000 ha. Total potential for expansion is around 5,000 ha in the wet season; the economic viability of this however, requires deeper investigation due to low soil fertility and persistent flooding problems. The inefficient diesel pumping units presently installed would need to be replaced by electric motors and a substantial investment made in upgrading water supply canals and drainage networks. A possibility deserving of investigation is the supply of irrigation water by gravity from the THPC power station once this is expanded.

Along the Nam Hinboun, maybe up to fifty percent of the potential for expanded irrigation will be developed over the next 5 years. This will amount to around 2,000 to 3,000 ha. The foreseen developments in the agricultural sector are not expected to have any impact on the hydrological regime and flow patterns in the zone that will be significant compared to those caused by other sectors such as hydropower.

2.4.3 *Xe Bangfai Basin and Surrounding Districts*

The Xe Bangfai Basin has a total catchment area of 10,406 km² (MRC Database), extending from the Lao-Vietnam border in Khammuan Province to its confluence with the Mekong mainstream at the conjunction of Khammuan and Savannakhet Provinces. Since the early 1970's, considerable road, flood-protection and irrigation infrastructure has been installed. As its headwaters are at a relatively low altitude, no hydropower development is envisaged on the Xe Bangfai River, but it is destined to receive the turbinated discharges from the proposed NT2-HPP Power Station. In preparation for this eventuality, the lower half of the Basin has been classified into potential hydrological impact zones. These are described below before proceeding to classify the various tracts according to their landuse management characteristics.

Because a considerable portion of the Xe Bangfai headwater catchment lies in a limestone karst landscape with very little natural vegetative cover, flash floods

are a frequent occurrence during tropical depression events. There is no practical way to prevent this occurrence, but only mitigate its effects through wise choice of riverside building and farming sites.

The Xe Bangfai sub-catchment may be sub-divided into the following tracts:

Bangfai Headwaters (Bualapha District)

This incorporates the sub-catchment basins, Nam Phit and Nam Kathang/Nam Gnom. There are 23 villages containing 1,632 households and 12,722 persons. Population density is 38 persons per km². The Nam Phit traverses the Mahaxay Plain and will be modified to carry the turbinated water from the Power Station. The Nam Kathang traverses the Nyommalat Plain and will carry the drainage from the irrigation system to be augmented by a part of the turbinated waters. Xe Bangfai stream bank erosion will be severest in this zone. The 500kV and 115kV Transmission Lines will also traverse this tract.

Nyommalat District Reach

The 5-Year Scenario in these tracts will depend largely upon the answers to the queries raised below.

Reportedly, plans for the conversion of the Nam Phit Valley into the Discharge Canal for turbinated water from the NT2 Power Station in Nyommalat incorporate outlets for irrigating farmlands in both the Nyommalat and Mahaxay Plains en route to the discharge point on the Xe Bangfai. Whether or not this provision results in the expansion and intensification of irrigation in these tracts, depends upon several factors, including the following:

Will the planned outlets be at sufficiently high level to provide gravity command of irrigable lands, or will the water need to be pumped from the canal?

The present small irrigation systems in the Nyommalat and Mahaxay Plains are inefficient and inadequately infrastructured. Is it the intention to use NT2 compensation funds to rectify this situation? Or will this be incorporated into a loan or grant project?

Will the turbinated water be of acceptable quality for irrigation purposes?

Will the turbinated water discharge regime be sufficiently compatible with the regime of irrigation water requirements?

Effective use of available irrigation water requires not only "state of the art" civil works, but also competent rural institutions (the Interest Groups, Village Development Associations) to negotiate the necessary land acquisition for the irrigation civil works and to operate the system for equitable water distribution and to organise the maintenance and good working condition. Before commencing construction for upgrading, twelve months are required for establishing and training these rural institutions. Has this been provided for?

In the middle and lower Xe Bangfai some of the potential areas for irrigation expansion will have been developed while plans for upgrading and rehabilitation of existing schemes may have been realised by the provincial irrigation departments of Khammuan and Savannakhet. The World Bank funded Agriculture Development Project will have finished the construction of 3 new irrigation schemes comprising 460 ha in Nyommalat and 2 schemes in Thakhek District totalling 250 ha. It needs to be ascertained whether the projects in Nyommalat will be able to benefit from the NT2 turbinated waters, or are they entirely separate? Both government and external funding for rehabilitation of old schemes and additional irrigation development throughout the Xe Bangfai Basin will have been secured to a certain degree; in this respect, the prevailing acute

budgetary shortage, both for investment and for the payment of adequate remuneration for civil servants will not yet have been relieved under the 5-year Scenario. Hopefully, under the 20-year Scenario, revenues from the NT2 and other export-oriented hydropower projects will have relieved this situation. This would allow a "breathing space" to enable currently over-exploited production forests to recover their revenue-earning capacity. With respect to NT2 revenues, ADB is currently conducting a technical assistance support project for public expenditure planning.

The higher water levels in the Xe Bangfai during the dry season may have led to some limited energy savings in connection with pump irrigation, offsetting to some degree reduction of wet season rice cropping area due to higher wet season flood levels. The energy savings to be made however, by improving the conveyance and distribution efficiency of the irrigation networks (through civil works upgrading) would far outweigh any energy savings due to higher dry season water levels.

Xe Bangfai District Reach - Middle Impact Zone

The zone lies in the Xe Bangfai District of Khammuan Province and contains 12 villages, with 709 families and 3,900 persons; population density is 38 persons/km². This zone would be moderately affected by flood levels in the wet season and stream bank erosion due to NT2 power generation discharges. The zone extends from just below the Phu Soy Range until the start of the Xe Bangfai flood plain (Lower XBF). It also incorporates the lower Xe Noy sub-catchment.

Lower Xe Bangfai Reach

This reach is subject to annual inundation by Mekong floodwaters, in some places up to 3 metres deep. It extends from Route 13 South westwards to the banks of the Mekong River (Lower Xe Bangfai Impact Zone). This zone lies in the Districts of Xaibouly of Savannakhet Province and Nong Bok and Xe Bangfai Districts of Khammuan Province; there are 53 villages, containing 4,998 families with 27,489 persons (NT2HP Social Development Plan, Table 14-1). Population density is 76 persons per sq. km. Due to Xe Bangfai river levels being masked by the proximity of the Mekong, no negative impacts from NT2HP operation are foreseen.

3 PART 3: RECOMMENDATIONS

3.1 Policy & Legal Framework

In September 2004, Lao PDR ministers and provincial governors met to discuss the management of forest and timber business, including illegal logging and timber trade. They also discussed the promotion of tree plantations and approved the draft Prime Minister's Order on forest management and timber trade for 2004-2005. This order defines rules for logging, wood exportation and the level of forestry management by local and central authorities in order to increase efficiency of the use of forest resources (Vientiane Times, 27 September 2004).

The past half-century has seen considerable turmoil concerning policies and laws on land occupancy and use rights, particularly in China, Lao PDR, Vietnam and Cambodia. The terms and conditions under which land is occupied has a significant bearing on the long-term agricultural productivity of the land, and on the sustainability of the cultivation practices employed by the land users. In the countries afore-mentioned, the situation concerning access to paddy land has been more or less resolved and has reverted to follow traditional practices whereunder the tiller retains the rights to use the land and to pass on that use right by inheritance to one or more descendants. In Lao PDR, the actual ownership is vested in the State, but the occupant is the owner of structures and crops on the land. Full ownership of lowland agricultural lands by landlords and individual farmers is the rule in Thailand, rather than the exception. Certificated land can be bought and sold and capital gains accrued. Landlordism has become a problem, exacerbating social disparity in some rural areas and reducing overall agricultural productivity. The Royal Thai Government is currently embarking on a land reform programme, redistributing land holdings in excess of 50 rai (about 7 ha) from former landlords to poor farmers.

Most of the agricultural land in Lao PDR is still held through traditional and customary rights but in the sedentary agricultural areas, these rights are held on a family basis, or on a village territory basis in shifting cultivation areas. Village Forest lands are held communally, while the State maintains ownership of all other forests. These forests are maintained for Watershed Protection, Biodiversity Conservation or State Production Forestry. In the latter, logging or plantation concessions may be granted to private sector corporations. In China since 1980, in an effort to regenerate forest cover on catchments of hydropower and irrigation schemes, numerous land tenure systems for non-State forestlands have been experimented with. Reportedly (Liu Dachang, 2001), individual family ownership of farm forests with State licensing of timber-cutting and selling rights has been most effective in rehabilitating the integrity of the river catchments.

In Lao PDR there are ongoing initiatives for urban and peri-urban land titling (under the World Bank-supported Land Titling Project) and rural land occupancy Certification (under the Landuse and Forest Zonation and Allocation Programme, operated by the Department of Landuse Planning and Land Development in the Office of the Prime Minister). A major rationale for the Land Titling Programme (which provides for full ownership of urban and peri-urban properties and the structures thereupon) is to provide a basis for increasing tax revenues from property sales. At this stage, the land allocation programme in the rural areas provides only temporary land occupancy certification (3 years viability). Much work is still required to link these with the sustainability of landuse in sloping catchment areas prior to the issuance of full title certification.

In Lao PDR, the Law on Water and Water Resources of 1996 is intended to assure sustainable use of water. Water use is categorised into small, medium and large-scale use. The legislation prescribes the rights and permit procedures for the different categories of water use. Development of a large-scale user projects will require the preparation of an EIA, particularly if the project is for hydropower generation or mining, with private sector involvement. Similar laws and provisions apply in Thailand, Cambodia and Vietnam. The policy and legal provisions concerning EIA are much less specific in the case of irrigation projects however and environmental awareness within the respective Departments of Irrigation is a recent and not yet thoroughgoing phenomenon.

With respect to hydropower development in the Lao PDR, the basic legal framework comprises the Environmental Protection Law and legislation covering forestry, land allocation, water use and resettlement. Neither in Lao PDR, nor in the downstream riparian countries, does the Environmental Law adequately cover the use or abuse of irrigation systems, or of sloping lands in catchment areas. Over the past 15 years, GoL has been supported by numerous technical assistance projects in the elaboration of policies and the promulgation of laws, decrees and guidelines, which address the standards of the international donor/lender organisations.

Estimates for increased water consumption show a need for three times the existing supply by 2025 when up to 80 million people may inhabit the Lower Mekong Basin, up from 55 million at present. Given the fact that the Basin's resources are finite, and already existing populations are expanding onto fragile habitats and marginal lands (at the expense of both terrestrial and aquatic biodiversity), there is cause for all riparian countries to follow China's example of policy-driven population growth limitation. If atmospheric and aquatic pollution is taken into account, continued urbanisation and industrialisation is not an environmentally compliant answer to ever-expanding human population.

3.2 Institutional Strengthening and Capacity Building

3.2.1 *Governmental Institutions*

Unlike the agencies in the energy sector, most Departments of Irrigation do not have Environmental and Social Management Units. Design criteria are not yet standardised and construction supervision in many cases is wanting, leading to reduced longevity and increased maintenance cost for civil works. Neither irrigation departments nor agricultural extension departments give due attention to guiding farmers in conservative and efficient irrigation water use, pollution control or drainage regimes. Much more support for the institutions responsible for irrigation system management is recommendable given the role of irrigation development as a means of increasing rural population carrying capacity and of limiting the need for upland rice production by shifting cultivation in catchments of river supplying water for water resources exploitation projects. These institutions range from central level water resources coordinating bodies to provincial and district irrigation departments, down to scheme-level water users associations and canal-level water user groups.

In Lao PDR, the administration of the Water Law is located in the Water Resources Coordination Committee, which has its Secretariat in the Office of the Prime Minister. Any consultant or agency with technical competence is capable of performing an impact study and estimate the associated mitigation, rehabilitation, restitution or compensation costs. The effective management of the associated water allocation, civil works rehabilitation, soil conservation, resettlement, etc. activities however, requires a multi-sectoral institution with administrative and

budgetary powers that go beyond those that can be mustered by a committee, which usually has no permanent technical staff. The coordinating body must maintain an equitable degree of parity between all relevant stakeholders, in terms of both their rights and their responsibilities in connection with the exploitation and conservation of the water resource.

Stakeholders in large basins, such as the NT2 impacted basins, or the Nam Ngum River Basin in Lao PDR, include several competing hydropower companies and downstream irrigators, navigators and fishermen. When the entirety of a large river system lies within the national boundaries of one particular country, then the institutional strategy for the management of the basin is to establish a commission (e.g. Snowy Mountains Commission in Australia) or an authority (e.g. the Tennessee Valley Authority in the USA). The Mekong however, is a multi-national river system and in designing a strategy for increasing its managerial effectiveness, it would be useful for the MRC to study the systems employed for managing large multinational river basins in Europe, such as the Rhine or the Danube.

The ADB has since 1996 been promoting integrated water resource management in Lao PDR through a number of technical assistance projects, which have resulted in the National Water Sector Profile, the Water Sector Action Plan and the establishment of the Water Resources Coordination Committee and the Nam Ngum River Basin Committee. The latter committee will be the body initially responsible for coordination of activities under the recently inaugurated ADB 'Nam Ngum River Basin Development Project' (PPTA LAO 33365-01). As well as addressing water allocation, poverty alleviation, catchment protection and biodiversity conservation issues within the Nam Ngum Basin and surrounding districts, it is intended that the project would also address the institutional strengthening and capacity building issues that could culminate in the establishment of a Nam Ngum Basin Management Authority or Commission.

One of the issues to be addressed is whether perhaps, to convert the Lao-Mekong Committee into a fully-fledged sub-commission of the MRC, with branches responsible for each major river basin in the country, in which two or more independent power producers operate. In the NT2 Catchment, a fledgling Watershed Protection Management Authority has been inaugurated which could, foreseeably expand to incorporate the Resettlement Management Unit, the Nakai Forest Farmer's Association, the THPC Environmental Management Division and arbitrate on monthly water allocation between the various stakeholders. The Authority could also organise and manage the associated resettlement, watershed protection and biodiversity conservation activities. It is a characteristic of Independent Power Producers that they prefer to concentrate on the implementation and management of the engineering aspects and could be expected to prefer to pay the costs of management of non-engineering aspects by a semi-governmental body, such as a River-Basin Management Authority or Sub-Commission.

Advisers to the UNDP-supported Lao Government Public Administration and Reform Programme identify the following prerequisites for effective capacity building at all levels of government:

- Clear, detailed technical specifications for the works for which the individual is responsible.
- Organisation diagrams clarifying, both vertical and horizontal interaction with other individuals and agencies.
- Precise and comprehensive job descriptions clarifying roles, duty stations and chains of responsibility and authority.

- Adequate accommodation and transportation facilities, especially for those located in remote duty stations.

In strengthening the role of Central and Provincial Governments as regulators and promulgators of an enhanced legal framework; upgraded salary and benefits scales will also be essential to relieve any legal justification for seeking such support from private sector developers. This will enable better government control of development projects, in line with international environmental and social parity standards.

3.2.2 *Non-Government, Community-Based, and Private Sector Organisations*

Several initiatives, which emphasise the role and effectiveness of NGOs and domestic consultants in implementing integrated development and emphasising poverty alleviation are in process in Lao PDR with the support of ADB. These projects include the Shifting Cultivation Stabilisation Project, the Smallholder Agriculture Project, the Industrial Tree Crops Project, the Nam Ngum Watershed Management and Conservation Project and the Sustainable Agro-Forestry Systems for Livelihood Enhancement of Rural Poor (Nam Ha Poverty Alleviation Project). These projects incorporate the upgrading of irrigation systems as a basic step towards reducing the necessity for shifting cultivation on steep watersheds and nature conservation areas. The latter two Projects feature a tripartite implementation modality, combining NGOs, domestic consultants and local government. The compensation package for the flooding of stream bank gardens in more than 25 villages by the THPC involved the installation of pumped irrigation, village water supply, sanitary toilets, health awareness raising, micro finance support, irrigation system upgrading and expansion, the terracing of rainfed sedentary farmlands and land allocation and certification. These activities were executed jointly by the THPC Environmental Management Division and local government, with technical support and capacity building provided by NGOs and domestic consultants.

Conversion of indigenous communities from shifting cultivation to a sedentary lifestyle or from non-irrigated to irrigated agriculture is necessarily a time-consuming process requiring a continuous programme of consultation with each family concerned. An important aspect of incorporating NGOs and domestic consultants into integrated development projects is their ability to assign and support resident technical personnel to live full-time in each village. This is not possible in the case of governmental community developmental and agricultural extension personnel, who have district-wide responsibilities. This approach is also yielding encouraging results in the project for empowering communities in the remote uplands of the Nakai-Nam Theun NBCA.

Nonetheless, to equip them for the complex task of managing the landuse change involved in integrated rural development, most NGOs and domestic consultants require capacity building. It is accordingly recommended that practical training courses for NGO and domestic consultant managerial and field staff be added to the curricula of the Mekong Institute at Khon Khaen University, the National Institute for Development Administration in Bangkok and its sister-organisations in Vientiane, Phnom Penh and Can Tho. Soil erosion control topics should also be added to agricultural university curricula and supplementary in-service training in this field be provided for field staff of governmental agricultural and forestry services.

A particular institutional consideration applies to the case of ensuring the integrity of the Basin's biodiversity conservation areas once that all irrigation possibilities in the buffer zones have been developed. The situation in the THPC catchment provides an example; this catchment incorporates the NNT, the Bolikhamxay

Highlands, Khammuan Limestone, Nam Kading and the Nam Chouan NBCAs and corridors, together with the proposed Pha Khadoung Saola Management Area, and the Pha Koanchan Provincial Protected Area. The community and agricultural developments implemented so far by THPC compensate the riverside farmers for the direct impacts of the project but do not (and ideally should not be expected to) compensate for the background impacts of unsustainable landuse, which was ongoing before the dam and power station were constructed. To fully stabilise landuse catchment-wide and thus remove the use pressure on biodiversity conservation areas (which is currently precluding their successful protection) it will be necessary to extend irrigation upgrading, rainfed farmland terracing, livestock health and nutrition improvement and land occupancy certification throughout the catchment. Hopefully, these activities could be implemented in conjunction with the resettlement site developments associated with the Theun-Hinboun Extension and Nam Theun 1 and Nam Theun 2 HPP should these transpire. The GEF funding to be administered by the WCS will cover matters specific to wildlife management but funding for irrigation development and shifting cultivation stabilisation has not yet been secured.

In designing institutional strengthening and capacity building programmes, the importance is stressed of keeping a balance between strengthening the capacity of the "top down" institutions and that of the "bottom up" institutions, particularly through Village Development Committees and their constituents: Water User Groups, Soil Conservation Groups, etc. It is much more likely that regulations concerning the utilisation and conservation of land, water and other natural resources will be adhered to when these are prepared in close consultation with the resident communities. (This matter is dealt with in detail in the publication 'Lao Environmental, Institutional & Background Research Project' under the auspices of the Strategic Environmental Framework for the Greater Mekong Sub-region' [ADB 5783]).

As an institutional strategy, it is recommended to grant conservation, research, eco-tourism and management concessions over wildlife sanctuaries and NBCA Core Zones to consortia of international conservation-oriented NGOs in return for payment to the government of concession fees and royalties as (part) compensation for the opportunity cost of not logging the NBCAs.

3.3 Technical Aspects and Best Practices Leading to Sustainable Rural Landuse Intensification

EIA and CIA should lead to informed decisions on whether or not to proceed with a particular infrastructural project in favour of another, or at least to choose the option that ensures minimal disruption of the livelihood of the community at large in both current and trans-generational scenarios. In reality however, all too often investment in civil works and the design and layout of structures are more influenced by short-term political and financial agendas, than by longer-term environmental social and ecological considerations. It would seem wiser then for EIA and CIA to concentrate more on mitigating the emergence of worst-case scenarios or, at least, managing and mitigating their impacts if they cannot be prevented. For this reason, in Part 2 above, the various catchments comprising the Nam Theun 2 HPP Impact Zones have been described in terms of their component "landuse management" tracts, as an aid to classifying the various impacts and to planning and quantifying their management and mitigation and attributing the relevant costs to the relevant stakeholders.

A large number, perhaps the majority, of irrigation schemes in Thailand and Lao PDR are of inefficient design and have been poorly maintained and managed. Rather than further expansion into marginal lands, it would be much more economical to upgrade existing irrigation systems and to upgrade managerial capacity.

The main aspects to be considered in irrigation development are: 1) civil works design & layout, 2) sophistication of operation & maintenance, 3) cropping regimes, and 4) power source (in the case of pumping schemes). Apart from access to water sources, the main factors limiting the further expansion of irrigation in the Mekong Basin are topography and soil characteristics such as porosity and (potential) salinity. Agricultural land that is beyond the reach of irrigation water supply can also be sustainably developed for rainfed agricultural production. Again, technical inputs are required whose successful implementation demands the application of **Best Practices** to a chain of processes. These are outlined below.

3.3.1 *Data-gathering & Monitoring*

To be of maximum utility in the planning and monitoring of irrigation and other land development measures, the quite comprehensive socio-economic, topographic, landuse and infrastructural data already compiled by the MRC needs to be restructured into a geo-referenced framework built on Basic Statistical Units (BSU: village territories in rural areas, urban and suburban blocks in towns). The watershed classification maps require enhancement in the form of present landuse, slope and native ecotype overlays (GIS layers), based on interpretation of both ancient and recent aerial photography.

The MRC database relies on information received from each member country for planning the expansion and upgrading of irrigation systems; this database still requires some enhancement. While the locations of irrigation headworks are pinpointed and hectareage provided for irrigated area and sometimes for potential expansion, there is no indication of the technical sophistication of each irrigation system, or of irrigation efficiency. There is no cross-link to the associated village territorial data, so it is not possible to determine how far local subsistence needs are catered for, nor the capacity of the irrigated or irrigable areas to cater for increased population pressure. These data deficiencies could be overcome by technical inspection in the field, combined with a definition of village territorial boundaries, aided by aerial photo interpretation. It is doubtful if data to this level of sophistication is on hand at the provincial and district irrigation service offices.

Data on pinpointed irrigation schemes is partially incomplete. Particular attention needs to be given to recording conveyance and distribution efficiency plus the agricultural and ecological suitability of lands identified for irrigation expansion. Usually the most effective construction and operational monitoring is that carried out by project beneficiaries themselves, once they are familiarised with construction and operational plans and given the appropriate training. Status indicators should be chosen to be geo-referenced and provide for, *inter alia*, monitoring of crop, animal and wood fibre production, water runoff and quality, soil loss and atmospheric emissions emanating from each LMU. Population density and the status of institutional organisation and community services are also important aspects to be tracked.

According to Table I - 1, there exists considerable potential for expanding Basin irrigated areas both in the wet and dry season. What needs to be ascertained however, is how much of this potential expansion could be into flood reticulation wetlands (with adverse effects on the fishery) or onto soils of high porosity or low fertility (including salinity risk).

3.3.2 *Design of Civil Works*

The long-term public interest will best be served when civil works are designed for longevity, upgradability and ease of maintenance.

Irrigation Systems

Headworks: Should be designed to withstand at least the 100-year flood without damage and be equipped with de-sedimentation devices. Pumps, when fitted should be electrically powered wherever possible using motors with a high power factor rating thus economising on electricity consumption.

Distribution canal networks: Should be elevated sufficiently to command by gravity all those lands within reach that are suitable for irrigation. The canal network should be equipped to meter water independently by volumetric measurement to each farm holding. Canals should be aquaducted and culverted to allow for free passage of floods and fish. They should not be lined unless absolutely necessitated by scarcity of compactable natural construction materials. Weep-holes should be fitted to prevent lifting by groundwater back-pressure when the canal is empty.

Drainage Network: Should be adequate to allow each farmer to cultivate whichever dry season crop he chooses and whenever he chooses, without being flooded by the irrigation practices of his neighbours.

Electrical Connections: Switchboard wiring should be termite-proofed and motors should be protected from burnout by circuit breakers responding to excess current, excess voltage and phase-out conditions. Single-phase tapplings of the 3-phase transmission line serving the pumps should be disciplined so as to ensure an adequate voltage balance between each of the three phases.

On-Farm Works: Paddy field bunding should be continuous and aligned on the contour to allow of convenient and efficient water distribution and drainage and to ease access of cultivation and transportation equipment.

Access Roads

Farm, forest and plantation access roads should be designed with ease of labour-intensive maintenance in mind. Cross-sections should be high-crowned and wherever possible gradients should be less than 10% and adequately dimensioned drains and culverts installed to minimise erosion. Cuts and fill should be protected by phosphatically fertilised creeping vegetation.

Soil Conservation Works

Soil conservation earthworks should be designed to protect all sloping arable, grazing and plantation lands from erosion damage. Designs should cater for slopes between 5% and 12.5% being contour-bunded (average horizontal interval 8 metres) and slopes between 12.5% and 25% being terraced (maximum vertical interval 1 metre). Designs should envisage vegetative protection for both bunds and risers.

Fuller details are provided in the following reports, which were prepared for the Theun-Hinboun Power Company:

1. Installation, Operation and Maintenance of Streambank Garden/Orchard Water Supply Systems for the Theun-Hinboun Power Company Impacted Villages. EcoLao, Vientiane, April 2003 (EcoLao 2003).

2: Extension Strategy for Promulgation of Organic/Conservation Farming in the Catchment of the Nam Theun-Hinboun Hydropower Project Headpond (EcoLao 2003).

3.3.3 *Public Consultation & "Informed" Choice*

The public consultation approaches employed in Western countries with infrastructural development and associated resettlement mitigation or compensation need to be adapted to meet the cultural conditions pertaining in the rural areas of the Mekong Basin. Wholly "informed" choice concerning future livelihood and location options requires much more than information alone to be supplied to the indigenous communities, who have little appreciation or experience of alternative landuse systems. Proactive "Hands On" demonstration in the villages of livelihood alternatives is required. Truly informed choice comes, not from information and consultation alone but from hearing, seeing, touching and doing. PRA methodologies may be useful once the development measures are budgeted and in process, but the initial steps in public consultation should follow the POCA (Participatory Opportunities and Constraints Analysis) methodology. This has been applied in the preparation of the project proposals for the ADB-supported 'Sustainable Agro-Forestry Systems for Livelihood Enhancement of Rural Poor' (Nam Ha Poverty Alleviation Project) (ADRA 2003).

3.3.4 *Water Resources Infrastructure Operation & Maintenance*

Hydropower Schemes

Operating hydropower reservoirs with a view to maximising electricity production is not always in the best interests of the downstream irrigators. Operating rules may need to be modified to allow for precautionary releases from reservoirs when floods threaten, ensuring that downstream rice crops are submerged for no longer than three days at a time. Bypass releases may be required at times when generators are shut down if these coincide with periods of peak irrigation demand. The turbinated water discharge regime embodying gradual fluctuations in downstream water levels causes far less stream bank erosion than does a daily peaking regime.

Within the Nakai District headquarters town of Oudomsouk, twenty or more houses and shops will need to be relocated to make way for a reservoir saddle dam. The farming and gardening needs of the labourers and low-paid government officials to be relocated should not be overlooked when finalising the overall RAP.

Irrigation Schemes

Apart from charging for the volume of all irrigation water supplied (including a contribution to the cost of maintenance and repair of civil works) Water User Groups need to be educated in scheduling the times and amounts of irrigation water to be applied to each type of crop for gaining best advantage from the water supplied. Full details are available in the numerous technical manuals published by the Food and Agriculture Organisation of the United Nations. Some of these, however, may not yet have been adequately translated into local languages for use in farmer training sessions.

Before electrifying or otherwise upgrading the high-horsepower pump-irrigation systems for paddy fields along the Nam Hinboun, it will be advisable to investigate how far the irrigation requirements of the residents of the Hai-Hinboun Plain could be satisfied by gravity irrigation canals that followed the foothills adjoining the left and right bank flood plains of the Nam Hai respectively - the latter extended along the right bank of the Hinboun. These canals could be filled by pumping from the re-regulation pond, which would ensure a reserve supply of irrigation water for when the generators are not working. If extra turbines are to be added to the Power Station, then, by sacrificing one or two metres of head so that these turbines would discharge directly into the afore-mentioned irrigation canals (which

would need to be oversized) additional erosive discharge into the Nam Hai would be avoided.

3.3.5 *Tree Plantations*

A potentially important factor that will influence the forestry sector in the future is the development of tree plantations with fast growing species suitable for industrial use. BGA, a New Zealand-based funds management and investment company, currently has a plantation concession agreement covering 154,000 hectares in Bolikhamxay and Khammuan Provinces (Pak Kading and Hinboun Districts).

The main species planted are *Eucalyptus camaldulensis* (*Murray River Red Gum*) and *Acacia mangium*. The concession area is located between the Mekong and the mountain ranges extending from Pak Kading in the north to the mouth of the Hinboun River in the south. By no means will all of the concession area be available for corporate plantation estate, as the tract incorporates the territories of several villages who have been cajoled by government to release a portion of their shifting cultivation fallow land for the company's use, in return for wage labour opportunities and their own plantations with technical support, seedlings and markets organised by the company. There is, however, a need for parallel technical and financial support for the development of small irrigation systems on the numerous side streams traversing the concession area to compensate for former upland rice lands having been converted to tree plantations.

The ADB Industrial Tree Crops Loan espouses a similar pattern of nucleus estate and smallholder industrial tree plantation in other parts of Vientiane, Bolikhamxay and Khammuan Provinces. There would be great value in expanding this approach to the shifting cultivation villages in the catchments of the proposed hydropower projects in the Theun-Kading Basin, with the double aims of poverty alleviation and watershed protection. The land there is steeper than in the BGA concession area although soils are generally better; contour-bunding and roadside protection would need to be included in the plantation model

3.3.6 *Best Practices for Rainfed Agriculture, Grazing, Plantation, Forestry & Conservation*

These are briefly described below in Section 4.1.1, Five-Year Scenario (Year 2010).

Irrespective of whether the NT2-HPP proceeds, the agro-forestry and irrigation components of the NT2 RAP should be pursued. Rural roads should be upgraded and the rural electrification grid extended. All side streams should be gully-stopped and used as water sources for the electric powered irrigation of fruit trees, vegetables and supplementary dry season green forage for cattle and buffalo. These initiatives are long overdue:

Socio-economic surveys sponsored by NTEC in 1996 highlighted the depressed socio-economic situation of the Nakai Plateau residents.

The TH-HPP has been benefiting from runoff from the Nakai Plateau and the Nakai-Nam Theun NBCA catchments since 1998. A portion of its revenues should have been devoted since that time to promoting the welfare of the residents in this portion of its catchment. The GoL holds equity in both the Theun-Hinboun and the NT2-HPP ventures. Refunding of a portion of the agricultural and irrigation development costs to THPC could be arranged if, and when, the NT2-HPP comes on stream.

Because of the poverty situation of the villagers along the middle Nam Theun on the Nakai Plateau, there is a strong case for development of agro-forestry and

gully-stop irrigation in the "Resettlement Tract" before NT2 construction works commence.

The Resettlement Budget for Nam Theun 2 Reservoir Oustees is calculated at more than US \$20,000 per family over a 10-15 year period. Land development for sustainable agro-forestry based rural sedentarisation is estimated at about US \$4,000 over five years. It is considered reasonable to expect BOT hydropower developers to contribute an annual 1-2% of revenues for upgrading the livelihoods and thereby helping to preserve the integrity of the catchments, once revenue generation commences. It is however, difficult to expect company Boards of Directors to agree to increasing their up-front expenditure (and interest payments thereupon) by also investing in the development and stabilisation of catchment communities. The ultimate beneficiary of reducing soil erosion in the catchment and thereby slowing sedimentation of the Theun-Hinboun Headpond will be the government when it takes over the project completely after the expiration of the BOT period. A low-interest start-up loan to government, developer or joint venture from an international development bank is called for.

4 PART 4: PREDICTED LANDUSE SCENARIOS

Never before in the history of the world, has there been such a high human population, such a range of both new and second-hand technology, or such comprehensive and speedy global communications, including facilities for instantaneous international transfer of funds. The condition of the rural landscapes, comprising the various tracts of the Mekong Basin 5-Years and 20-Years from now, will be the resultant of the interaction and evolution of the various technological and landuse modalities and trends that are manifest today.

Whether the dependents and descendents of the 60 million or so residents of the Mekong Basin live in peace and prosperity or in poverty and deprivation, depends ultimately on the terms and conditions under which credit is granted to those who invest in or undertake: property development, fishery, forestry, construction and trade or industry (including operation of the factories which produce agricultural tools and equipment, earth-moving equipment, transportation vehicles and weaponry. There are many conflicts of interest to be resolved: urban contractors wish to keep building, but the mega-cities are becoming unmanageable; loggers wish to cut all of the trees, but conservationists wish to retain them; peasants wish to have large families, but governments are constrained to discourage them, and so forth.

The **5-Year Scenario** provided below presents a guess at what will probably happen as a result of the momentum of current trends, the majority of which are unsustainable in the long-term. The "No Intervention" scenario for 20-Years hence is unthinkable - locally, regionally and even globally: treeless, eroded hillsides; flooding; rural villages destroyed by landslides and mudflows; silted-up rivers turning to a trickle in the dry season; fished-out rivers and lakes; renewed violence due to increased competition for territory and declining resources; dysfunctional towns and cities and deteriorating investment climate.

Instead, the **20-Year Scenario** presented hereunder indicates the situation that could emerge through the application of **Best Practices** in each aspect of development, not only in the field of engineering, but also in agriculture, forestry and conservation, together with the software activities that support their sustainable management. These practices are known today, it is a question of amassing the political will and upgrading the awareness and capacity of all stakeholders. Those who furnish the investment funds will have the responsibility

of ensuring that the best and the most sustainable construction and management practices are followed.

4.1 Basin-wide Perspective

As population expands, competition for water resources will increase and the need to make efficient use of the available resources will become imperative. Appropriate water policy and the application of the "user pays" principle are basic to ensuring frugal water use.

The legal basis for land use and land ownership is provided in the Land Law of 1996 and Land Decree No. 99. In principle, the State owns all land but long-term occupancy and utilization rights for individuals are recognised. A significant cumulative impact resulting from the implementation of the NT2-HPP could be and increased demand for land in the neighbourhood of project-related developments, increased land prices and increased activity by local government and the National Land and Forest Zonation and Allocation Programme in certifying and titling lands in the impact zone, in both irrigated areas and in the catchments.

4.1.1 Five-Year Scenario (Year 2010)

China

In China, the ongoing development strategies listed, and their manifestations, can be expected to persist for at least the next five years:

- Rural population density stabilisation through birth control and urban drift;
- Accelerated construction of mainstream hydropower projects to reduce dependence on imported fossil fuels;
- Reforestation of steep reservoir catchments;
- Expansion of tree plantations, especially industrial tree crops such as rubber;
- Improved maintenance of existing irrigation systems.

Myanmar

- As Myanmar gradually re-integrates into the global community, the following short-term trends are expected in its Mekong River catchment areas:
- Extension and upgrading of the road network, including international border crossings with Thailand, Lao PDR and China;
- Completion of the hydro-electric project in the Upper Mae Kok tributary;
- Upgrading of irrigation systems, for which there is generally limited potential for expansion due to topographic unsuitability.

North Thailand

Short-term trends in North Thailand will be driven mainly by the Northern Economic Corridor Highway (Ban Houay Xay to Ban Bor Taen in Lao PDR, with a proposed bridge linking Houay Xay and Chiang Khong in North Thailand), together with the ongoing strategies of rural land reform and the "One Tambon (sub-district), One Product" decentralised economic production programme:

- Expansion and industrialisation of Chiang Khong district town/river port;
- Some reversal of the rural to urban drift with agricultural intensification and diversification;

- Upgrading of existing irrigation systems and expansion of erosion-protected rainfed agriculture on lands of low slope;
- Intensified industrial tree crops plantations on steeper lands.

Northeast Thailand

- A swing is expected away from the production of irrigated dry season rice towards industrial crops, such as jute, kenaf, sugarcane, oilseeds and specialist crops, e.g. vegetable seeds and exotic fruits;
- Strengthened protection of conservation areas along the mountain ranges and, to a certain extent, some wetlands may be protected;
- The ongoing trend for expansion of industrial tree crops plantations on rolling ex-farmlands exhausted by cassava production and in some cases into rainfed paddy fields, can be forecast;
- The ongoing programme of upgrading existing irrigation schemes by relining canals and installing metering devices will continue.

Cambodia

Given the ongoing support from the international community through multi-lateral and bi-lateral agencies and NGOs, some slowdown in ongoing trends of ecological degradation of fisheries and forests can be expected as road access into the countryside is steadily upgraded.

- Family planning will commence to take hold;
- Exploitive logging in the catchments will probably continue unabated in the short-term;
- Some progress may be made in gradually re-foresting wetland spawning grounds for fish;
- Further irrigation schemes will be installed in the Delta;
- Rainfed agriculture will be intensified with concentration on livestock production;
- Industrial tree crops plantation may extend to some areas currently marginal for agriculture as road access improves.

Vietnam Central Highlands

Overpopulation and environmental "meltdown" will remain as grave problems in Vietnam for some years to come. There is little, if any, scope for irrigation expansion due to topographic constraints and groundwater depletion. Some improvements in irrigation efficiency can be expected, also a move to diversify away from monoculture tree plantations, particularly coffee, for which the export price is depressed because of global over production. An upsurge in wood fibre producing plantations can be expected as the in-country timber processing market is depending more and more on imports.

The Mekong Delta

Of all the tracts in the Mekong Basin, the Mekong Delta is the most vulnerable to wet season floods and dry season low flows brought about by upstream deforestation and agricultural expansion. The consequent loss of life and property in the wet season floods, and brackish water intrusions in the dry season, have a high impact because of the high population density. They are extremely difficult to mitigate by infrastructural works in situ. The environmental situation in the Delta

will be mitigated when large hydropower projects upstream are commissioned, but this will not happen appreciably within the next five years.

4.1.2 *Twenty-Year Scenario (Year 2025; Assuming Best Practices)*

With the expansion of energy, transportation and irrigation infrastructure foreseen over the next 20-Years, it can be expected that there will remain no more "remote and isolated" areas in the Basin, except for those purposively gazetted as such in the shape of nature conservation and watershed protection "core" zones. Under "Best Practice" development and management, the characteristics pertaining to each category of landuse would be as listed below. Hydrologically, all of the landuse practices listed would be returning the runoff situation to, as far as practicable, the "pre-disturbance" condition, i.e. maximum retention of wet season rainfall in the catchment, to re-emerge as dry season stream flow. Water and atmospheric pollution would be minimised and carbon sequestration maximised. Note that population pressure and economic considerations would eliminate shifting cultivation as a landuse option for the long-term future:

- *Nature and Watershed Protection Forests*: fire-protected, regularly patrolled and guarded by wardens recruited from, and interacting with, the local communities.
- *Slow-growing timber production forests*: fire-protected, guarded and operated under sustained-yield management concessions to which local communities are both signatories, and partial beneficiaries. The pre-designed, pre-constructed logging roads and tracks would be regularly maintained. Management practices regularly monitored by such agencies as the Forest Stewardship Council, incorporating the preservation of seed trees, the restriction of harvests to no more than the Mean Annual Increment (MAI) growth rate and the maintenance of a closed canopy. Management of the wildlife and non-timber forest products within the production forest territory would be entrusted to the local communities, they having been provided with the knowledge and capacity to do so.
- *Fast-growing tree plantations*: fire-protected and equipped with well-maintained and erosion-protected roads and access tracks. Soil-erosion control works installed on steep slopes.
- *Pastures and grazing lands*: fenced, fire-protected and fertilised, restricted to slopes less than 12.5%.
- *Sedentary rainfed arable farmlands*: restricted to slopes less than 25%, slopes greater than 12.5% being terraced and slopes between 5% and 12.5% contour-bunded. Bunds regularly maintained and protected by vegetation. Terraced croplands interspersed with strips of deep-rooted trees as a safeguard against landslides. Soil fertility maintained by a combination of organic composts and phosphatic fertilisers.
- *Irrigated farmlands*: equipped with regularly maintained "state-of-art" water delivery and control structures and operated "frugally" by farmers made conversant with the timing and quantity of crop water requirements.
- *Flood-prone paddy fields*: operated as "rice-fish" farms, employing traditional rice varieties requiring low, or no, inputs of chemical fertilisers or pesticides with supplementary income deriving from "water-proof" animals such as buffalo, ducks, fish, frogs, shrimps, snails, etc.

- Flood-free irrigation schemes: concentrating on the production of wet season rice and alternative crops (including forage for livestock), in the dry season. Emphasis on integrated pest management and the use of bio-pesticides.
- If, and when, rural population density reaches a critical threshold of about 1,000 persons/km², there will be no space to raise large livestock for draught and manure. If out-migration is not considered a viable option, then there is no alternative but to continue to rely on mechanisation and "chemical farming" with their associated economic and environmental consequences.

4.2 Lao PDR Perspective

4.2.1 Five-Year (Year 2010) Scenario

It can be expected that the ongoing rate of donor/lender-supported transport, energy and irrigation infrastructural development activities will continue throughout most of the next 5 years. Despite pressure from the environmental and conservation lobby, it can be expected that exploitive logging will continue as at present until most of the easily accessible timber has been exhausted. At the same time, however, increased reforestation and regeneration activity can be expected on logged-over forests or shifting cultivation areas. Rural electrification will steadily enable the conversion of pumped irrigation systems from uneconomic diesel-driven units to electrical power.

It is reasonable to expect that most of the irrigation expansion potential will be taken up within the next five years. Upgrading, however, would take much longer. The results of ongoing and projected landuse stabilisation initiatives such as the 'Sustainable Agro-Forestry Systems for Livelihood Enhancement of Rural Poor' (Nam Ha Poverty Alleviation Project), the 'Nam Ngum River Basin Development Project' (PPTA LAO 33365-01) and the Sustainable Forestry Rural Development Project, should be available as a basis for extending the stabilisation of agricultural and forest landuse (with improved atmospheric and hydrological consequences) throughout the ensuing decade. Resettlement and compensation experience, connected with the NT2 and THPC HPPs will also provide guidance in this matter, as will lessons learned from the better designed irrigation schemes, such as the Nam Ngum Pumped Irrigation Project (EU-supported), the Tan-Pieo Pump Irrigation Project (AFD-supported) and the WB-funded ADP irrigation upgrading programme.

In the Conservation Sector, the buffer zone activities associated with the above-mentioned Nam Ha Poverty Alleviation Project, the GEF-funded activities (through WCS) in Bolikhamxay Province, (including the Theun-Hinboun Catchment) and the ECRU and associated programmes in the Nakai-Nam Theun NBCA would be ready to provide valuable guidance in extending effective nature conservation country-wide.

4.2.2 Twenty-Year Scenario (Year 2025; Assuming Best Practices)

Income from hydropower generation will have substantially raised hard currency revenues while increased land tax and agricultural production tax revenues arising from rural landuse stabilisation, certification and poverty alleviation should have enabled the rationalisation of public expenditures and provided the appropriate salaries and allowances to ensure the effective performance of a "lean and mean" government establishment. Through enhanced forest protection and regeneration, improved timber processing and marketing linkages and efficiency (including Forest Certification), the Forestry Sector revenue base should have become sustainably revitalised. Furthermore, with improved health and education services,

combined with the adoption of best technical practices, population growth rates should have declined and the sustainable landuse scenarios as described in the Basin-wide, 20-Year scenario above, should apply to each category of landuse in Lao PDR.

4.3 Local Perspective - NT2-HPP Proximal Impact Zones

4.3.1 *Five-Year (Year 2010) Scenario*

From the viewpoint of soil quality, topography, water availability and freedom from flooding, the most attractive tracts for irrigation upgrading and (limited) expansion are the upper Nam Phao/Kata catchment and the Nyommalat, Mahaxay, Xaibouathong and Xe Bangfai District tracts of the Xe Bangfai Basin. In the latter basin, the irrigation upgrading will depend on the conversion of diesel-powered pumpsets to electricity. It could be foreseen that the promise of electric power supply from NT2-HPP could trigger the expansion of rural electrification, catchment-wide. Because of low soil fertility and high flood risk, the Hai-Hinboun Basin is less attractive from the irrigation development viewpoint. Nonetheless, the current irrigation systems, having diesel pumps and sub-standard distribution networks are not economically viable and it could be expected that the THPC contribute part of its (expanded) revenues to upgrade this situation.

It is expected that fast-growing tree plantations with community involvement will have commenced to extend out of the Nam Thon and Lower Hinboun catchments into the ex-shifting cultivation lands in the territories of villages along Route 8 between the Nam Theun crossing and Lak Xao. Considerable development of ecotourism to the various rivers, cliffs, caves and nature trails in the Theun-Kading and Hinboun Basins should have occurred. Most, if not all, of the commercial logs in the Xe Bangfai Basin will have been exploited within five years. Their replacement by fast-growing industrial plantations may have commenced. A similar situation could apply to the adjacent catchments on the Vietnam side of the border.

4.3.2 *Twenty-Year Scenario (Year 2025; Assuming Best Practices)*

Given the judicious application of a percentage of the revenues from expanded hydropower generation, it could be expected that: i) maximisation of sustainable irrigation possibilities, and ii) stabilisation of rainfed landuse on slopes would have relieved use-pressure on fragile wetlands and forested uplands and highlands. This would have been sufficient to enable secure conservation of the various nature reserves and wildlife sanctuaries located in the proximal impact zone, including the Pha Khadoung Saola Management Area, but possibly excluding the Vu Quang National Park in Vietnam. This tract may perhaps be more practicably operated as a multiple-use Buffer Zone, given the proximity of the Ho Chi Minh Highway. Plantation forestry (softwoods) and commercial production forestry (hardwoods) would have been re-vitalised and commenced to produce a sustainable source of taxation, royalty and direct revenues for Government. If all three proposed hydropower developments in the Theun-Kading Basin are realised, then up to 3,000 rural families will have been resettled onto pump-irrigated agro-forestry landholdings, following livelihoods sustainably above the poverty line.

It is expected that agriculture in the Xe Bangfai Basin would be further commercialised with production of diversified crops for an expanded market. The main local markets for agricultural products would be Thakhek and Nongbok, which would have seen a substantial growth in their populations. The neighbouring areas in Vietnam and Thailand plus more remote domestic markets such as Savannakhet and Vientiane should also have expanded. In spite of the

diversification of cash cropping, production of rain-fed and irrigated rice will still be a significant agricultural activity in the Xe Bangfai Basin.

It may be expected that much of the potential area for irrigation will have been developed through the assistance of external funding, while many of the existing irrigation schemes will have been rehabilitated and upgraded. An estimated half of the wet and dry season potential for expanding irrigation will have been achieved; this amounts to around 7,000 and 5,000 ha for the wet season and the dry season respectively. Irrigated dry season cropping will also have diversified to include crops like maize, soybean, peanuts and a number of vegetable crops, together with irrigated forage for supplementary feeding of stall-fed livestock.

Bibliography

- A Practical Guide to Irrigation Water Scheduling*. HR Wallingford. Spark & Makin, Wallingford, 1992 (*Spark, 1992*)
- Adventist Development & Relief Agency (ADRA). *Project for Poverty Alleviation, Land Use Stabilization and Environmental Protection in the Upper Nam Ha Watershed, Northern Economic Highway Corridor (ADB Route 3)*, Vientiane, 2003. (*ADRA, 2003*)
- Asian Development Bank (ADB RETA 5828). Study of Large Dams & Recommended Practices. *Terms of Reference for Domestic Consultants*. Vientiane, July 1997. (*ADB, 1997*)
- Asian Development Bank (ADB RETA 5828). Study of Large Dams & Recommended Practices. *Case Study Report: Nam Ngum 1 Hydro-power Project, Lao PDR*. SEATEC/AITA-NET/Lahmeyer/Schema Konsult. Vientiane, February 2000. (*Seatec, 2000*)
- Asian Development Bank (ADB TA 3139-PRC). Policies and Strategies for Sustainable Development of the Lancang River Basin - Chapter 4, *Water Resources in the Lancang River Basin*; Plinston & He Daming, Landcare Research New Zealand, May 2000 (*ADB, 2000*)
- Asian Development Bank (ADB TA 3189-LAO). Technical Report No. 3. *National Strategy for Irrigation Development, Incorporating Irrigation Management Transfer & Strategic Plan for National Training & Extension for Irrigation*. BMB Management Consultants, February 2000. (*BMB, 2000*)
- Asian Development Bank (ADB TA 5783). *Lao Environmental, Institutional and Background Research Project: Strategic Environmental Framework for the Greater Mekong Sub-Region 2000*. EcoLao/Stockholm Environmental Institute, 2000. (*EcoLao, 2000*)
- Asian Development Bank. *Handbook on Resettlement: A Guide to Good Practice*; ADB, 1998 (*ADB, 1998*)
- Asian Development Bank. Benefit Monitoring as a Component of Integrated Rural Area Development Project Design. Oñate, Manila, 1979. (*ADB, 1979*)
- Biology International (IUBS). *Rain Forest Regeneration and Management*. Hadley, UNESCO, Paris, 1998 (*UNESCO 1998*)
- CARE International in Lao PDR. Recommendations to CARE International concerning the Project "Samet Area: Forest Rehabilitation & Livelihood Security (SAFRALS)". EcoLao, Vientiane, October 2000. (*EcoLao 2000*)
- CARE International in Lao PDR. *Report to CARE International Layout of Pilot Demonstrations for Soil Erosion Control on Tractor-Cultivated Farmlands in Paklay District, Xainyabouly Province, Lao PDR*. EcoLao, Vientiane, March 2001. (*EcoLao 2001*)
- CARE International in Lao PDR. *Samet Area: Forest Rehabilitation & Livelihood Security (SAFRALS)*. CARE, Vientiane, December 2000. (*CARE 2000*)
- Environmental and Social Impact Assessment of the BGA Industrial Tree Crop Plantations in Bolikhamxay and Khammuan Provinces, Lao PDR*. EcoLao, Vientiane, 2002. (*EcoLao, 2002*)
- Evapotranspiration of crops by remote sensing using the energy balance based algorithms*. Yann Chemin, Asian Institute of Technology, 2003. (*AIT, 2003*)
- Farmers in the Forest: Economic Development & Marginal Agriculture in Northern Thailand*. Kunstadter et al. East-West Center, Hawaii, 1978. (*Kunstadter, 1978*)
- Food and Agriculture Organization of the United Nations (FAO). *Cooperative Processing of Agricultural Produce*. FAO, Bangkok, 1987. (*FAO, 1987*)

Food and Agriculture Organization of the United Nations (FAO). FAO Forestry Paper 59. *The Ecological Effects of Eucalyptus*. FAO, Rome, 1989. (FAO, 1989)

Food and Agriculture Organization of the United Nations (FAO). FAO Investment Centre Technical Paper 6. *The Design of Agricultural Investment Projects - Lessons from Experience*. FAO, Rome, 1989. (FAO, 1989)

Food and Agriculture Organization of the United Nations (FAO). FAO Irrigation & Drainage Paper 24. *Guidelines for Predicting Crop Water Requirements*. FAO, Rome, 1977. (FAO, 1977)

Food and Agriculture Organization of the United Nations (FAO). *Irrigation Management Transfer in Asia*. FAO & IIMI. Geijer, Bangkok, 1995 (FAO, 1995)

Food and Agriculture Organization of the United Nations (FAO). *Lao PDR: Shifting Cultivation Stabilization Project - Preparation Report, Volumes 1-8*. FAO/ADB. October 1998. (FAO, 1998)

Food and Agriculture Organization of the United Nations (FAO). *Organic Materials as Fertilizers*. FAO & SIDA. Rome, 1975 (FAO, 1975)

Food and Agriculture Organization of the United Nations (FAO). *Resource Management for Upland Areas in Southeast Asia*. FAO, IIRR Manila, 1995. (FAO, 1995)

Food and Agriculture Organization of the United Nations (FAO). *Watershed Management in Asia & the Pacific: Needs & Opportunities for Action*. FAO, Rome, 1986. (FAO, 1986)

Forests and Trees of the Central Highlands of Xieng Khouang, Lao PDR, A Field Guide. Lehmann et al. for DANIDA, Vientiane, 2003

Government of Lao PDR, Prime Minister's Office. *National Environmental Action Plan 2000*. Vientiane, July 2000. (GoL - STEA, 2000)

Government of Lao PDR. District Upland Development & Conservation Project (DUDCP) (IDA CREDIT 3186-LA). *Domestication of Non-Timber Forest Products (NTFPs) in the nakai-Nam Theun NBCA*. Foppes, June 2001. (Foppes 2001)

Government of Lao PDR. Hydropower Development Strategy Study. *Guidelines for Developing Hydropower Resettlement Policy for Lao PDR*. Vientiane, August 1999. (GoL - Hydro, 1999)

Government of Lao PDR. Regional Workshop on Land Institutions & land Policy Consultations for a World Bank Policy research Report: *Case Study on Government's Policy & Strategy Program for Land Use Planning & Administration in Lao PDR*. Phoumy Vongleck, Phnom Penh, June 2002. (Vongleck 2002)

Government of Lao PDR. *Lao People's Democratic Republic: Northern Region Development Planning Strategy, Executive Summary*, Draft Final Report. Committee for Planning & Cooperation, Northern Eight Provinces & Special Region, Asian Development Bank, Vientiane, February 2004. (ADB, 2004)

Government of Lao PDR. *The National Poverty Eradication Programme (NPEP): A Comprehensive Approach to Growth & Development*. Vientiane, September 2003. (GoL - NPEP, 2003)

Government of Lao PDR. *The National Poverty Eradication Programme (NPEP), Background Document*. Vientiane, September 2003. (GoL - NPEP, 2003)..

Information Systems for Agriculture. Blackie & Dent, Applied Science Publishers, London, 1979.

Interim Committee for Coordination of Investigations of the Lower Mekong Basin (MKG/R.454). *The Se Bang Fai Plain, Lao PDR, Pre-Feasibility Study of Floodway and Small Structures*. Mekong Secretariat, Bangkok, January 1984. (Mekong Secretariat, 1984)

Interim Committee for Coordination of Investigations of the Lower Mekong Basin. *Nam Theun 1 Hydroelectric Project, Feasibility Study, Phase I*. SWEC, HEC, September 1992. (*Nam Theun 1, 1995*)

Interim Committee for Coordination of Investigations of the Lower Mekong Basin. Report on Consultancy to the Soil Erosion Project. SIDA, Mekong Secretariat; G.A. Oughton, Vientiane. (*Oughton, 1993*)

International Union for the Conservation of Nature (IUCN). *Bolikhamxay Province Environmental Inventory*. Ministry of MCTPC/IUCN/SIDA, March 2000. (*IUCN, 2000*)

International Union for the Conservation of Nature (IUCN). *Khammouane Province, A preliminary Environmental Inventory*. IUCN/SIDA, March 2000. (*IUCN, 2000*)

Irrigation and the Environment: A Review of Environmental Issues, Part II - Environmental Considerations in Planning and Operation. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, 1993. (*GTZ, 1993*)

Laboratoire Forestier de Toulouse. *La Végétation du Laos, 2^{me} partie - Groupement Végétaux et Flore*. Toulouse, 1960. (*Vidal, 1960*)

Lao-Swedish Forestry Programme, IUCN, MAF. *Review of the National Protected Area System of Lao PDR*. Robichaud, et al. Vientiane 2001. (*Robichaud, 2001*)

Measures of Success: Designing, Managing, and Monitoring Conservation and Development Projects. Margoluis & Salafsky, Island Press Washington DC, 1998. (*Margoluis, 1998*)

Mekong River Commission. Basin Development Plan (BDP): *Water Used for Agriculture in the Lower Mekong Basin*. MRC Secretariat, Phnom Penh, July 2003. (*MRC 2003*)

Mekong River Commission. Basin Development Plan (BDP): *State of the Agriculture Sector in the Lower Mekong Basin*. MRC Secretariat, Phnom Penh, July 2003. (*MRC 2003*)

Mekong River Commission. Basin Development Plan. *Regional Sector Overview, Agriculture and Irrigation*. MRC, Phnom Penh, 2002. (*MRC, 2002*)

Mekong River Commission. *Lower Mekong Basin: Future Trends in Agricultural Production*, discussion paper. Phnom Penh, 2002. (*MRC, 2002*)

Mekong River Commission. Sustainable Irrigated Agriculture Project (SIRAP). *Gender Development in Irrigated Agriculture in SIRAP Irrigated Schemes*. Rodenburg et al. Bangkok, March 1996. (*MRC, 1996*)

Mekong Secretariat. Mekong Irrigation Programme. Economic Analysis: MIP Pump Irrigation Projects. DHV Consultants, Amersfoort, Netherlands; September 1990. (*MRC 1990*)

Ministry of Agriculture and Forestry, Department of Forestry, National office for Nature Conservation and Watershed Management. *Control of Soil Erosion, Sedimentation & Flash Flood Hazards*. Oughton, Vientiane, September 1993. (*Oughton, 1993*)

Ministry of Agriculture and Forestry, Department of Irrigation. *Feasibility of Medium and Large Scale Irrigation Schemes in 7 Large Plains in Lao PDR*. JICA, Vientiane, March 2000. (*GoL - MAF, 2000*)

Ministry of Agriculture and Forestry, Department of Irrigation. Nam Ngum Pump Irrigation Project (European Commission ALA/LAO/88/02). *Review of Economic Feasibility, Volume I Main Report*; ELC-Electroconsult, Milano, February 1993. (*Electroconsult 1993*)

Ministry of Agriculture and Forestry, Department of Irrigation. Nam Ngum Pump Irrigation Project, 1994 (European Commission) *Proposal for Project Extension & Expansion of Project Scope*; ELC-Electroconsult, Milano, 1994. (*Electroconsult 1994*)

Ministry of Agriculture and Forestry, Department of Water Resources. *Nam Cheng Irrigation Project - Appraisal Report*. Vientiane, 1986. (*GoL - MAF, 1986*)

Ministry of Agriculture and Forestry, Forest Inventory and Planning Centre. *Forest Inventory and Preliminary Harvesting and Management Considerations, Nam Theun 2 Resettlement Tract, Nakai District and Gnommalat District, Khammouane Province*. Vientiane, November 2001. (GoL - MAF, 2001)

Ministry of Agriculture and Forestry. *Assessment of the conditions of sustainability of the resettlement program of the populations of Nakai Plateau - Assessment of the productive livelihood options of the resettlement action plan*. IRAM, Paris, August 2004. (IRAM, 2004)

Ministry of Agriculture and Forestry. Vietnam – Laos Cooperation Program on Water Resources Planning, 1999, *Project on Water Resources Development Planning for Khammouan Plain, Final Report*. Hanoi, June 2000. (Vietnam – Laos, 2000)

Ministry of Agriculture and Forestry. Vietnam – Laos Cooperation Program on Water Resources Planning, 1999, *Project on Water Resources Development Planning for Savannakhet Plain, Final Report*. Hanoi, June 2000. (Vietnam – Laos, 2000)

Ministry of Agriculture and Forestry. *Concept for an Upland Development & Poverty Alleviation Programme*. Vientiane, December 2000. (GoL - MAF, 2000)

Ministry of Agriculture and Forestry. *Forestry Strategy to the Year 2002, Second Draft*. Vientiane, October 2003. (GoL - MAF, 2003)

Ministry of Agriculture and Forestry. Lao-ADB Plantation Forestry Report - Loan No. 1295 (SF). *1996: Environmental baseline Survey report*. CIRAD/Burapha, Vientiane, February 1997. (GoL - MAF, 1997)

Ministry of Agriculture and Forestry. Sustainable Forestry Rural Development Project (SUFORD), *Annual Work Plan 2003-2004*. MAF, Vientiane, December 2003. (GoL - MAF, 2003)

Ministry of Agriculture and Forestry. Vietnam – Laos Cooperation Program on Water Resources Planning, 2000, *Project on Water Resources Development Planning for Bolikhamxay Province, Final Report*. Hanoi, November 2000. (Vietnam – Laos, 2000)

Ministry of Finance, Department of Lands. Land Titling Project (IDA Loan CR 2832 LA). *Existing Land Tenure & Forest Lands Study* (Draft Study Report). Lao Consulting Group, Vientiane, May 2002. (LCG, 2002)

Ministry of Industry & Handicrafts. *Environmental Management Standard Documents*. Vientiane, 2001 (GoL - MIH, 2001)

Ministry of Industry & Handicrafts. *Environmental Management Standard for Electricity Projects*. Vientiane, 2003 (GoL - MIH, 2003)

Ministry of Industry & Handicrafts. *Regulation on Implementing the Environmental Assessment for Electricity Projects in Lao PDR*. Vientiane, 2001 (GoL - MIH, 2001)

Nam Theun 2 Hydroelectric Project. *Environmental Assessment and Management Plan, Main Text, Draft*. NTEC, Vientiane, 2003. (NTEC 2003.)

Nam Theun 2 Hydroelectric Project. *Policy recommendations on Alternatives to Agricultural Chemical Utilisation in the Nam Theun 2 Hydropower Project Resettlement Area*. EcoLao, Vientiane 2001. (EcoLao, 2001)

Nam Theun 2 Hydroelectric Project. *Social Development Plan, Volume 2: Resettlement Action Plan*. NTEC, Vientiane, December 2003. (NTEC 2003)

Nam Theun 2 Hydroelectric Project. *Social Development Plan, Volume 3: Appendices*. NTEC, Vientiane, 2003. (NTEC 2003)

Nam Theun 2 Hydropower Project (NTEC). *Forest Resources and Management Options in the Nakai Plateau Resettlement Area*. Margules Pöyry, June 1997. (Margules Pöyry, 1997)

Nam Theun 2 Hydropower Project (NTEC). *Location and Land Suitability of Nakai Plateau Resettlement Sites*. Margules Pöyry, June 1997. (Margules Pöyry, 1997)

Nam Theun 2 Watershed Management and Protection Authority. Social and Environment Management Framework and 1st Operational Plan (1 Feb 2004 to 30 April 2010), *Volume 1, Management Framework and Operational Plan (Advanced Draft)*. Vientiane, April 2004. (NT2 WMPA, 2004)

Nam Theun 2 Watershed Management and Protection Authority. Social and Environment Management Framework and 1st Operational Plan (1 Feb 2004 to 30 April 2010), *Volume 2, Folio of Annexes and Maps (Advanced Draft)*. Vientiane, April 2004. (NT2 WMPA, 2004)

Royal Thai Government, Public Welfare Department. *Perennial Tree Fruits for the Highlands of North Thailand: Methodology for Site & Crop Selection, Development & Extension*. Chapman, Queensland, Australia, 1993. (Chapman, 1993)

TDR Quarterly Review. *The Hydrological Roles of Forests in Thailand*. Nipon Tangtham, September 1994. (Tangtham, 1994)

Tenure and Management of Non-State Forests in China since 1950: A Historical Review. Liu Dachang, in *Environmental History*, Volume 6, Number 2, April 2001 (Liu Dachang 2001)

The Ecological Changes in Manwan Reservoir Area and its Causes: Soil Erosion Report. He Daming Zhao Wenjuan et al., Asian International Rivers Centre, Yunnan University; Kunming

The Lao Kingdom of Lān Xāng: Rise and Decline. White Lotus, Bangkok, 1998. (Stuart-Fox, 1998)

Theun-Hinboun Hydropower Company. *Assessment of Compensation due to Villagers Impacted by Flooding of Farmlands by the Theun-Hinboun Headpond and Downstream Discharges*. EcoLao, Vientiane, October 2001. (EcoLao, 2001)

Theun-Hinboun Hydropower Company. *Extension Strategy for Promulgation of Organic / Conservation Farming in the Catchment of the Nam Theun-Hinboun Hydropower Project Headpond*. EcoLao, Vientiane, April 2003. (EcoLao, 2003)

Theun-Hinboun Hydropower Company. *Installation, Operation and Maintenance of Streambank Garden/Orchard Water Supply Systems for the Theun-Hinboun Power Company Impacted Villages*. EcoLao, Vientiane, April 2003 (EcoLao 2003)

Theun-Hinboun Power Project, Mitigation of Project Impacts. *A 10 Year Mitigation & Compensation Program*. Resource Management and Research, Vientiane, June 2000. (THPC, 2000)

Tropical Legumes: Resources for the Future. National Academy of Sciences, Washington DC, 1979. (National Academy of Sciences, 1979)

University of Texas. *Koppen Climate Classification Flow Chart*. Kimmel, July 2000. (Kimmel, 2000).

Wildlife Conservation Society. *Preliminary Management Plan for Nakai Nam Theun National Biodiversity Conservation Area*. WCS, March 1995. (WCS, 1995)

Wildlife Conservation Society/IUCN/CPAWM. *Wildlife in Lao PDR, 1999 Status Report*. Duckworth et al., 1999. (IUCN, 1999)

World Bank. Lao PDR Production Forestry Policy: Status & issues for Dialogue, Volume II Annexes. WB/Min. of Foreign Affairs/Government of Finland, July 2001 (WB, 2001)

World Bank. World Bank Staff Working Paper No. 272. *A System for Monitoring & Evaluating Agricultural Extension Projects*. Cernea & Tepping, Washington, 1977. (WB, 1977)

World Bank. World Bank Technical Paper No. 127. *Watershed Development in Asia: Strategies and Technologies*. Doolette & Magrath, Washington, 1991. (WB, 1991)

World Wildlife Fund (WWF). *Delineation of Ecoregions*. WWF, 2001. (WWF, 2001)



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ANALYSIS AND NAM THEUN 2 CONTRIBUTIONS



Annex 6: Health and Population Growth

Prepared by: Stanley Zankel

November 2004

TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	THE CURRENT HEALTH SITUATION	1
2.1	Preface	1
2.2	Presentation of Available Data	2
2.3	Recent Improvements	5
2.4	Challenges Ahead	6
3	EXISTING HEALTH SERVICES IN THE PROJECT INTERVENTION AREA	6
3.1	Introduction to the Area	6
3.2	Health Facilities in Khammouane	7
3.3	Health Staff in Numbers	8
3.4	Difficulties and Constraints in the Existing Health System	10
3.5	Village and Household Level.....	11
4	EXTERNAL ECONOMIC DEVELOPMENT SCENARIOS IN THE KHAMMOUANE REGION	12
4.1	Savannakhet-Khammouane Region Development Plan	12
4.2	Tourism	13
4.3	Infrastructure	13
4.4	Industry.....	14
4.5	Future Scenario.....	14
5	MIGRATION AND URBANIZATION IN THE SAVANNAKHET- KHAMMOUANE REGION	15
5.1	Urbanization in the SKR.....	15
5.2	Migration in the SKR	15
5.3	Survey: “Labour Migration”.....	16
5.4	Migration to Thailand.....	18
5.5	Future Migration Trends.....	20
6	PREDICTION OF CUMULATIVE IMPACT	20
6.1	The 5 Year Scenario	20
6.1.1	Nakai Plateau and Nakai – Nam Theun NBCA	25
6.1.2	Xebangfai Basin and Surrounding Districts	33
6.1.3	Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts	34
6.1.4	Mekong River Basins	35
6.1.5	Neighbouring Areas in Vietnam and Thailand.....	35
6.2	The 20 Year Scenario	36
6.2.1	Nakai Plateau and Nakai – Nam Theun NBCA	36
6.2.2	Xebangfai Basin and Surrounding Districts:	38
6.2.3	Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts	39
6.2.4	Mekong River Basins	39
6.2.5	Neighbouring Areas in Vietnam and Thailand.....	39
7	SUMMARY OF “BUSINESS AS USUAL” AND “BEST PRACTICE” SCENARIOS	40
7.1	The NT2 Health Action Plan.....	41
7.2	“Business as Usual” and “Best Practices” Scenarios	43
7.2.1	HIV/AIDS & STIs	43
7.2.2	Vehicular and Other Accidents.....	46
7.2.3	Mental Health, Depression, Suicide	50

7.2.4 Insect-Vector Borne Diseases.....53
7.2.5 Water Supply, Environmental Sanitation, and Related Communicable Diseases:56
7.2.6 Other Relevant Health Issues59
8 CONCLUSION: 62

LIST OF TABLES

Table 1: Key Indicators of Health for the 3 Provinces Included in the NT2 Project.....3
Table 2: Existing Health Infra-Structure in Khammouane Province.....7
Table 3: Medical staff by facility and district.....9
Table 4: Percentage of Migrant Workers According to Occupation and Gender.....19
Table 5: The Residence/site of Work of Lao MW in Thailand According to Region.....19

1 INTRODUCTION

As the largest infra-structure initiative in the Lao PDR, the Nam Theun 2 Hydro-power Project will undoubtedly affect the health status of those living in the project intervention areas, as well as inhabitants of adjacent geographic areas. Although the NT2 Project will act as the catalyst for most health-related impacts, other concurrent and future development projects may synergistically interact to set the stage for a radically different health picture than the one that currently exists. These cumulative impacts on health will affect the rural communities and small towns of Nakai, Nhommalat, and Mahaxay Districts of Khammouane Province, and to a lesser extent, communities in Xebangfai, Nongbok, and Hinboun Districts in Khammouane, as well as Kamkeut (Bolikhamsay) and Xaybouly (Savannakhet).

Being able to reasonably predict potential cumulative impacts affecting health, over a 5-20 year time span, is not an easy task. Twenty years ago, for example, few scientists would have predicted the successful outcome of the human genome mapping exercise, or many of the recent advances in molecular biology, that have dramatically expanded our present awareness and understanding of how to approach health and treat disease. Similarly twenty years ago very few health professionals would have foreseen that HIV/AIDS would explode into a raging pandemic that presently affects more than 40 million people around the globe. The situation in the Nam Theun 2 Project intervention area is considerably less dramatic or complex, but in order to make predictions about cumulative health impacts one needs to review a number of inter-related factors. This includes the overall health situation presently found in various locales of the proposed Nam Theun 2 Project intervention area. It also encompasses potential developments that can arise during the 5-year reservoir-power station construction and village resettlement phase, as well as other concurrent and/or future external macro and micro-economic developments that are reasonably expected to take place locally, nationally, and regionally.

2 THE CURRENT HEALTH SITUATION

2.1 Preface

Since 1995 the NTEC, WB, and ADB, have commissioned a myriad of studies, surveys, and health action plans to determine the health status of local residents of selected communities in the NT2 Project intervention area and plan for their needs. The NT2 Project Office is a repository for dozens of reports outlining the prevalence as well as severity of specific illnesses found in the NT2 Project intervention area. Some of these documents focus attention on identifying specific NT2 Project sector interventions [e.g. irrigation and hydrology] that can potentially increase the incidence and prevalence of vector and water-borne diseases. Other reports discuss communicable disease issues and problems that can emerge with the influx of 4,200 workers, as well as many thousands of camp followers and/or other people migrating to the camp sites and district towns, during the pre-COD phase. Many of these studies, and scenarios, include detailed recommendations on ways to mitigate or reduce the adverse affects that can impact on health. These studies, however, generally focus on the 5-year construction period, and do not take into account other macro and micro-economic developments that are reasonably likely to concurrently take place in and around the NT2 Project intervention area. They also do not take into consideration other future

developments that may shortly arise as a result of the completion of the NT2 Project.

Determining a population's health status is not a simple exercise, especially in developing countries where health statistics are often incomplete, not collected or reported on a regular basis, or simply non-existent. Interpreting provincial-level statistics is often compounded by the fact that there may be substantial disparities between urban and rural communities, and/or between rural communities with access to roads and those that do not have any roads. Even in the latter category there are many variables that affect health. This may include the fact that a community is located many hours, or several days walk, from the nearest health facility. For some ethnic minority communities linguistic and cultural differences frequently make it difficult to effectively communicate with government health officials. This may influence the cultural acceptability of available health services.

2.2 Presentation of Available Data

Most of the figures indicated below derive from the *Lao Reproductive Health Survey 2000* (LRHS) and the *National Health Survey 2001* (NHS). The Provincial level data generally derives from the *Summary Report of Provincial Data Analysis* that the National Statistics Center published in the early part of 2003. The LRHS covered all 18 provinces. It included 21,067 households, 40 villages per province, and 30 households per village. The NHS was considerably smaller, but since many of the demographic and health issues were already covered in the LRHS, it was nevertheless statistically representative of the entire country. The NHS also covered 18 provinces, but only 6,600 households, 264 villages, and 25 households per village. With respect to communities in Khammouane, Bolikhamxay, and Savannakhet provinces, the NHS respectively collected information from 12, 26, and 7 villages.

The table below, also includes information obtained from other health surveys as well as statistics extrapolated from MOH publications:

On the surface the figures listed below suggest that health status, especially for vulnerable groups [women of reproductive age and young children], in the Lao PDR is still quite poor. It is a picture of communities still affected by a wide range of vector and water-borne diseases, influenced by ecological and environmental conditions, and compounded by the lack of access to clean sources of potable water as well as the safe disposal of human wastes. The figures also reflect poor access to comprehensive Maternal and Child Health (MCH) services, which include ante-natal, delivery, post-partum, and family planning-birth spacing services for women of reproductive health; and immunization (EPI), nutritional surveillance, and basic health care for infants and young children.

On closer investigation, however, it is considerably more complicated to interpret national and even provincial level health statistics. A key indicator determining a nation's health status is the Maternal Mortality Ratio (MMR). This is the number of women dying from pregnancy related causes, and/or during labor, and within the 6-week period following delivery. In the Lao PDR the MMR is 530 maternal deaths per 100,000 live-births. One of the reasons that MMR is considered such a sensitive indicator of health is that "child-birth" is a natural phenomenon, and while many women experience discomfort and pain, it is generally not a life-threatening event. To illustrate this fact, over the past 5-year period, the Mother and Child Health Hospital in Vientiane, has encountered 1 maternal only mortal-

ity, even though this facility each year probably performs the highest number of deliveries in the nation. The maternal death, in question, involved a woman experiencing obstructed and prolonged labor, who lived outside of Vientiane, and arrived at the hospital beyond the point where medical staff could be of assistance. Although MMR is often attributed to educational levels, occupation, and socio-economic status, in fact it is directly associated with having access to essential and/or emergency obstetrics care (EOC). Thus an unemployed or uneducated woman living in the capital of Vientiane, or in the provincial centers of Thakhek, Khanthabouly, or Pakxan, would have a much better chance of surviving a complicated delivery than a university graduate teaching in a school in Nakai District of Khammouane. Nakai hospital staff, for example, presently are not trained or equipped, to provide EOC (especially Caesarian Section procedures) to women experiencing obstetrics emergencies.

Table 1: Key Indicators of Health for the 3 Provinces Included in the NT2 Project

Health or Demographic Indicator	National and Provincial Rate				National Ranking		
	National	KM	BLX	SVK	KM	BLX	SVK
Crude Birth Rate (# Births/1,000 Population)	34 .0	37. 0	36. 9	37. 4	9	8	11
Crude Death Rate (# of Deaths/1,000 Population)	6.3	10.8	3.6	6.4	18	2	9
Natural Rate of Growth (% Annual Population Increase: Crude Birth Rate – Crude Rate)	2.8	2.6	3.3	3.1	5	14	11
Infant Mortality Rate (# of Children Dying < 1Year of Age/1,000 Live-Births)	82 .2	91. 5	26. 0	98 .7	15	2	17
Under Five Mortality Rate (# Children Dying <5 Years of Age/1,000 Live-Births)	106. 9	116. 2	47. 7	123. 9	15	2	17
Total Fertility Rate (Expected # of Children Born to a Woman During Her Repro- ductive Life-time)	4. 8	5. 4	5. 0	5. 0	10	7	8
Family Planning: (Contraceptive Prevalence Rate (% Married Women Using a FP Method)							
-All Methods	32. 2	24. 2	33. 3	30. 7	12	5	6
-Modern Methods	28. 9	23. 9	32. 7	30. 1	11	5	6
-Traditional Methods	3. 2	0. 4	0. 2	0. 6	15	16	12
-Unmet Need for FP Services	39. 5	33. 9	48. 1	41. 9	N.A.	N.A.	N.A.

Health or Demographic Indicator	National and Provincial Rate				National Ranking		
	National	KM	BLX	SVK	KM	BLX	SVK
Delivery Practices							
-% of Deliveries in Past 5 Years that Took Place at the Home of Expectant Mother	86.1	80.7	87.9	85.4	16	13	14
-% of Deliveries in Past 5 Years Assisted by a Trained Health Worker							
-Assisted by Health Personnel	17.4	18.2	13.6	14.0	5	8	7
-Assisted by TBA	13.2	13.0	2.8	7.7	6	10	7
-Assisted by relatives/friends	55.1	52.0	70.2	63.5	13	5	10
Ante-Natal Care (% Pregnant Women in the Past 5 Years that did not Receive Ante-Care)	75.8	77.9	75.4	71.4	8	6	4
Malaria (Data from CMPE-2002)							
# Malaria Cases	267,454	34,379	8,861	49,816	N.A.	N.A.	N.A.
- Morbidity / 1,000 Patients	48.5	104.7	44.9	61.5	N.A.	N.A.	N.A.
- Mortality / 100,000 Patients	3.5	5.5	1.0	2.1	N.A.	N.A.	N.A.
- Population Protected by IBNs	73.3	83.2	76.5	83.5	N.A.	N.A.	N.A.
Acute Respiratory Illness (ARI)							
# ARI Cases < 5 Years of Age	48,235	5,562	1,535	14,064	N.A.	N.A.	N.A.
-Est. Incidence Rate	5.5	10.7	4.9	11.0			
Diarrhea							
# Diarrhea Case < 5 Years of Age	17,792	1,476	871	3,182	N.A.	N.A.	N.A.
-Est. Incidence Rate	2.0	2.8	2.8	2.5			
# Deaths of Diarrhea < 5 Years of Age	36	6	1	4			
EPI Coverage (% of children 0-11 months [for BCG & DPT3], children 0-23 months [for Measles] and Women of Child Bearing Ages [for TT2+] receiving immunizations)							
-BCG	48.9	60.0	46.7	62.6	N.A.	N.A.	N.A.
-DPT3	35.7	46.0	32.3	52.8	N.A.	N.A.	N.A.
-Measles	30.3	34.3	29.0	44.5	N.A.	N.A.	N.A.
-TT2+	37.6	28.5	26.9	56.2	N.A.	N.A.	N.A.
Water & Sanitation (from LECL & II Surveys 1998/1999)							
-% of Households With Access to a Clean Source of Water	50.0%	38.0%	65.0%	66.0%	N.A.	N.A.	N.A.
-% of Households with Latrines	29.0%	14.0%	22.0%	11.0%	N.A.	N.A.	N.A.

Health or Demographic Indicator	National and Provincial Rate				National Ranking		
	National	KM	BLX	SVK	KM	BLX	SVK
HIV/AIDS (NCCA June 2003)							
-# blood samples tested	91,003	5, 196	637	12,609	N.A.	N.A.	N.A.
-# HIV infected	1,102	92	9	487	N.A.	N.A.	N.A.
-# AIDS cases	599	17	9	286	N.A.	N.A.	N.A.
- # AIDS deaths	461	17	6	248	N.A.	N.A.	N.A.
Knowledge of HIV/AIDS & STI Transmission (LRHS 2000)							
-Know how HIV/AIDS is Transmitted	69. 3	65. 5	49. 6	81. 3	N.A.	N.A.	N.A.
-Know how STIs are Transmitted	52. 0	45. 9	36. 2	49. 0	N.A.	N.A.	N.A.

If the data in Table 1 was presented according to geographical or ecological zone, with a cross reference to the type(s) of existing health facilities and the capacity/competencies of local health manpower, the numbers would vary considerably, even within the same province as well as within the same district. This is an important concept, or fact, to understand if one is to predict the cumulative impacts on health as a result of the NT2 Project. The health status of ethnic minorities, especially those living in remote mountainous and forested regions of the country, often several days-walk to the nearest health facility, is quite different than that of residents living in the provincial, or at times district, center. Thus Crude Birth Rates, Infant Mortality Rates, Under Five Year Mortality Rates, Total Fertility Rates, Contraceptive Prevalence Rates, EPI Rates, % of pregnant women delivering in a hospital or health center with a trained birth attendant; % and incidence of children < 5 years of age dying or suffering from diarrhea, acute respiratory illnesses, and malaria, etc. for Thakhek, Khanthabouly, and Pakxan, and some of the larger district centers situated along the Mekong River are probably more similar to the figures found in semi-urban Thailand than for that reported above by the LRHS and NHS.

2.3 Recent Improvements

It is also important to recognize that specific patterns of morbidity and mortality can dramatically change in a very short period of time. In less than four years, since the completion of the LRHS and NHS, the National Malaria Control Project has greatly reduced the number of illnesses and deaths caused by malaria throughout Khammouane province. This development has substantially reduced the number of patients visiting or being admitted to district hospitals, and will undoubtedly be reflected in lower maternal, infant, and under 5 year old mortality rates in the National Census scheduled for 2005. During this same 4-year period the National Reproductive and Birth Spacing Programme has trained health workers as well as Village Health Volunteers (VHVs) and Traditional Birth Attendants (TBAs) nation-wide, to provide information, counseling and selected services to women and children. All health facilities in Khammouane, for example, are now provided with contraceptive services [e.g. oral and injectable contraceptives, and condoms] for interested couples, while provincial and district hospital

personnel can insert IUDs. These services, if understood, appreciated, and accepted by local communities, can within a very short period of time and in an extremely cost-effective manner exert a tremendous momentum in reducing maternal and infant mortality rates, especially for rural and remote areas in the NT2 Project intervention area. They are also a key variable in reducing population growth rates.

2.4 Challenges Ahead

Illness and death are a natural part in the cycle of life. Thus as certain health problems and issues are resolved, successfully managed or controlled, or disappear, others almost immediately emerge upon the horizon. Training health workers, and decision-makers, to understand this phenomenon and to observe new health developments in their early-stages, is essential for improving and/or maintaining good health for a given population. Thus as malaria, outbreaks of diarrheal diseases, and complications caused by acute respiratory illnesses amongst young children, gradually becoming less serious issues, the health and other relevant sectors need to be prepared to deal with new patterns of morbidity and mortality. This has already begun to include vehicular accidents, Sexually Transmitted Infections [STIs] & HIV/AIDS, and a wide range of emotional health issues such as depression, anxiety, and suicide. In Khammouane while some of these new health issues are anecdotally becoming more prevalent in and around the provincial and district centers located along the Mekong River, they are nevertheless gradually permeating outward into the key districts that comprise the NT2 Project intervention area. The nature of the construction and resettlement interventions planned during the 5-year pre-COD phase, in addition to other macro and micro-economic developments envisioned for Khammouane and neighboring geographic areas, will definitely exacerbate the potential impact of these new patterns of morbidity and mortality in the NT2 Project intervention area. How serious they eventually become, will to a great extent depend upon the level of concern and awareness of NT2 Project staff, local government, local communities, and the local health sector, as well as the combined willingness to take pro-active measures before a potentially dangerous situation spirals out-of-control.

3 EXISTING HEALTH SERVICES IN THE PROJECT INTERVENTION AREA

3.1 Introduction to the Area

The number of health facilities in the Lao PDR has dramatically increased during the past decade. Nevertheless there are still serious inequities with respect to the distribution of qualified manpower and the location of these sites throughout the nation, within provinces, and even within selected districts. The relatively few central and regional hospitals, located in the Vientiane Municipality and the large provincial centers in the northern (Luang Prabang), central (Savannakhet), and southern (Champassack) sections of the country, account for the largest number of experienced and qualified physicians, surgeons, technicians and public health specialists. The MOH has tried to rectify this situation by constructing new facilities, renovating and modernizing existing sites, as well as offering expanded in-service training opportunities to improve the technical, clinical, and administrative capacity of health workers at all levels. However many problems continue to persist. Many existing hospitals and health dispensaries are under-utilized due to

a lack of appropriate medical supplies and equipment, and/or the low competency-skill levels of the service providers.

3.2 Health Facilities in Khammouane

The health care delivery system in Khammouane, the main site within the Nam Theun 2 Project intervention area, is similar to several other large provinces in the country. As one leaves the provincial capital of Thakhek situated alongside the Mekong River, and heads eastward through the Mekong plain, up into the hills, and then into the more remote mountainous forests, the number of health facilities and the qualifications of local medical staff dramatically decline. Below are two tables illustrating the distribution of health manpower, as well as the actual location of health facilities, in Khammouane.

Table 2: Existing Health Infra-Structure in Khammouane Province.

Province & Districts	Provincial & District Hospitals			Health Centers		Village Level					
	Hospital Level	Prov. Hosp. Beds	District Hosp. Beds	Total # Health Centers	# Functioning Health Cent.	# of Villages	# Poor Villages	# Vill. > 3 Hrs to HC	# VHVs	# TBAs	# Rev. Fund Drug Kits
Thakhek	PH	150	26	13	12	141	0	8	220	64	15
Mahaxay	B		15	6	6	89	69	31	91	11	33
Nongbok	B		15	10	10	72	20	0	72	72	29
Hinboun	B		15	17	17	166	13	22	87	36	34
Nhommalat	B		15	5	5	71	57	58	71	71	42
Boualapha	B		15	3	3	82	78	52	93	30	11
Nakai	B		15	5	5	67	49	48	100	10	26
Xebangfay	B		15	7	6	50	2	0	105	10	46
Xaybouathong	B		15	4	3	68	61	52	66	66	5
Total		150	146	71	67	806	349	271	905	430	235

Table 2 graphically illustrates the unequal distribution of health facilities located in Khammouane. The largest concentration of hospital beds and health centers are concentrated in the three districts [Thakhek, Nongbok, and Hinboun] situated along the Mekong River, where it should also be noted that the majority of the people in the province live. Although the province has 67 functional health dispensaries, approximately half of these sites are located in the “homes” of local health staff and are not “formal” health facility structures. Most health centers situated > 3 hours from the home of prospective clients are concentrated in the eastern and remoter districts of Nakai, Boualapha, Xaybouathong, Nhommalat, and to a lesser extent Mahaxay. What these figures do not indicate, is that many health dispensaries are actually located more than a 1-2 day walk from the district hospital. Thus seriously ill patients are often beyond the reach of appropriate health care in times of severe illness or emergency. These are precisely the geographic locations where the vast majority of maternal, infant, and under-five year old mortalities occur.

3.3 Health Staff in Numbers

Khammouane has a total of 755 health personnel stationed at 1 provincial health office and 1 adjacent provincial hospital, 9 district hospitals with 9 adjacent health offices, and 67 village level health dispensaries. Health personnel can be divided into two categories comprised of 666 medical staff and 89 non-medical staff. Of the 9 medical staff who completed post-graduate or higher education, all are based at the provincial health office (7) or the provincial hospital (2).

Of the 63 medical staff who completed university level [generally referred to as “Phaet San Sung”], 47 are physicians, 12 are pharmacists and 4 are dentists. Of these categories, 32 (68%) of the physicians are either based at the provincial health office (5) or provincial hospital (27). Five of the districts each have only 1 physician, 2 districts each have 2 physicians, while another 2 districts each have 3 physicians. Of the 15 physicians deployed outside the provincial capital, 6 are stationed at district health offices, 7 at district hospitals, and only 2 at health dispensaries.

Of the 12 pharmacists, 9 (75%) are either based at the provincial health office (8) or provincial hospital (1). The remaining three pharmacists are deployed to two district hospitals and 1 health dispensary. Of the 4 dentists, 2 (50%) are stationed at the provincial hospital, while the remaining two individuals are deployed to two district hospitals.

Of the 173 medical staff who completed a “mid-level” pre-service health curricula [generally referred to as “Phaet San Kang”], 90 are medical assistants, 16 are nurses, 14 are assistant pharmacists, 4 are assistant dentists, 12 are physiotherapists, 21 are laboratory assistants, 9 are hygienists, and 7 are prosthetics assistants. None of the last six categories of health workers are deployed to the health dispensary level. Of these six categories more than 50% of the total cohort are deployed at the provincial level.

Of the 90 medical assistants, 38 (42%) are either at the provincial health office (21) or provincial hospital (17); 48 (53%) are deployed to district health offices (30) or district hospitals (18); while only 4 (4%) are found at health dispensaries. Similarly of the 16 nurses, 5 (31.5%) are deployed to the provincial health office (1) or provincial hospital (4), while 10 (62.5%) are deployed to district level facilities, and only 1 (6%) is at the health dispensary level.

Of the 421 medical staff who completed a “low-level” pre-service health curricula [generally referred to as “Phaet San Ton”] 389 are nurses, 5 are laboratory technicians, and 27 are pharmacy technicians. Of the 27 pharmacy technicians 12 are deployed to provincial level facilities, while 10 are dispersed between the 9 districts, and 5 are stationed at health dispensaries. Of the 5 laboratory technicians, 3 are at provincial facilities and the remaining 2 are at district facilities. Seven districts do not have any laboratory technicians whatsoever. Of the 389 nurses, 118 (30%) are at the provincial health office (26) or provincial hospital (92), while 172 (44%) are at district health offices (95) or district hospitals (77). The remaining 99 (26%) nurses are stationed at the health dispensary level. This is the only category of professional health worker that is deployed in relatively substantial numbers to health dispensaries.

Of the 89 non-medical staff deployed throughout Khammouane, the only one of significance at the health dispensary level are the “contracted staff” who frequently represent the only category of health worker stationed at remote health dispensaries. Of the 41 “contracted staff”, 37 (90%) are deployed to health dis-

dispensaries. Many of these “contracted staff”, deployed to the remote sections of Nakai, Nhommalat, Mahaxay, and Boualapha districts have only completed 2 or 3 grades of primary school. These individuals, however, generally have some previous medical experience, usually as former army nurses or medics. They have subsequently received an additional 6 months of “formal” medical education, at the provincial or district level, before being eligible for deployment to their respective health dispensary.

Of the 153 health workers [both medical and non-medical] deployed to the 67 health dispensaries throughout the province, almost 2/3 [i.e. 63.4%] are located in the three districts that are adjacent to the Mekong River/Plain [i.e. Thakhek, Hinboun and Nongbok]. As mentioned above, approximately half of the 67 health dispensaries in the province are not “formal” health facilities, but rather health stations established in the homes of the local “health staff”. Accordingly the types of services offered at these village level health facilities can dramatically differ from other “health dispensaries” located elsewhere in province or perhaps even within the same district.

Table 3: Medical staff by facility and district.

Personnel	Personnel By Facility					TOTAL	Personnel by Districts (including provincial level)										TOTAL
	Prov. Health Office	Prov. Hosp.	Dist. Health Office	Dist. Hosp.	Health Centers		Provincial	Thakhek	Mahaxay	Nongbok	Hinboun	Nhommalat	Boualapha	Nakai	Xebangfay	Xaybouthong	
Postgraduate level and higher	7	2				9	9										9
University graduate level	13	30	6	11	3	63	43	2	2	4	4	1	1	2	2	2	63
Medical Doctor	5	27	6	7	2	47	32	1	1	3	3	1	1	2	2	1	47
Pharmacist	8	1		2	1	12	9	1		1						1	12
Dentist		2		2		4	2		1		1						4
Nurse						0											0
Laboratory Specialist						0											0
Middle-level	35	48	46	39	5	173	83	5	9	14	13	8	12	8	12	9	173
Med. Asst	21	17	30	18	4	90	38	4	5	8	8	6	6	4	6	5	90
Nurse	1	4	4	6	1	16	5		1	4	1		2	1	1	1	16
Midwife						0											0
Assistant Pharmacist	4	3	2	5		14	7		2		1		1	2	1		14
Assistant Dentist		4				4	4										4
Physiotherapist		7	1	4		12	7			1	1		1		1	1	12
Laboratory Assistant	3	9	3	6		21	12	1	1	1	1	1	1	1	2		21
Hygienist	5		4			9	5				1		1		1	1	9
Prosthetics Assistant	1	4	2			7	5					1				1	7
Low-level	34	99	100	84	104	421	133	50	23	50	45	28	23	16	34	19	421
Nurse	26	92	95	77	99	389	118	49	21	49	40	27	21	16	31	17	389
Midwife						0											0
Lab. Technician		3	1	1		5	3				1		1				5
Pharmacy Technician	8	4	4	6	5	27	12	1	2	1	4	1	1		3	2	27
Non-Medical Staff	13	19	13	3	41	89	32	2	7	2	8	5	13	10	3	7	89

Univ. & Higher Level	1					1	1										1
Middle Level		1	1			2	1					1					2
Primary Level	4	6	4			14	10	1			1		1	1			14
Support Staff		6	1	2	4	13	6		2		3	1	1				13
Contracted Staff	8	6	7	1	37	59	14	1	5	2	4	3	11	9	3	7	59
TOTAL	102	198	165	137	153	755	300	59	41	70	70	42	49	36	51	37	755
District Office								18	17	21	20	22	16	13	24	14	
District Hospital								0	17	29	14	14	22	12	13	16	
Health Centers								41	7	20	36	6	11	11	14	7	

3.4 Difficulties and Constraints in the Existing Health System

The situation found in Khammouane, the primary site of the Nam Theun 2 Project, is not substantially different from other large provinces. It is generally difficult to find qualified health personnel willing to be deployed to remote district hospitals and health centers. Although the director of the district health office theoretically can decide whom to deploy or rotate to health dispensaries, he is often constrained by other factors beyond his control. These include the following issues:

- Staff salaries are insufficient to cover expenses associated with the actual cost of living. In the past it was also quite common for monthly salary payments to arrive late. This situation has created a need for district level health personnel to seek secondary occupations, such as agriculture or private medical services, to supplement their incomes and support their families. As such few staff are eager to be deployed to remote health centers.
- Few staff are eager or willing to be posted to remote areas that are plagued with poor living conditions, lack of social services, and/or isolation due to inadequate or non-existent road networks. A large number of remote health dispensaries, as mentioned above, are located anywhere from 1-3 days from the district hospital.
- Few government health personnel are members of ethnic minorities, and accordingly soon find themselves culturally and linguistically isolated from the communities they are sent to serve.
- Family members are also reluctant to move to remote areas, and it is rare for staff, unless they are not married, to take up a long-term assignment without being accompanied by their family.

These constraints have forced many districts to train local villagers, who are subsequently hired on a contractual basis, to be assigned to health dispensaries. In the Nakai District, for example, 10 of the 11 health workers deployed to the five health dispensaries are employed on a “contractual basis”.

The preceding section has emphasized some of the apparent weaknesses and constraints in the existing health care delivery system, as they directly influence the level and quality of health services presently available to various populations living in the proposed NT 2 Project intervention area. Although it is possible that this situation may greatly improve, over the next couple of years, this nevertheless is the context in which analytic scenarios for “*business as usual*” or “*best practice*” patterns need to be made. This statement does not necessarily imply

that it will be difficult or impossible to resolve most of the important health problems NT2 Project intervention residents currently face. New health issues and problems, however, related to the construction of the reservoir, power station, downstream channels, as well as other external economic development initiatives, may soon force health personnel to concentrate their efforts on a more select population living in towns and various camp sites. The nature and types of new health problems expected to emerge are also ones for which the existing health care system is presently unprepared or trained to handle. This includes an increase in vehicular accidents, the possible introduction of new vector-borne diseases such as Dengue Hemorrhagic Fever (DHF), or a sky-rocketing incidence and prevalence of HIV/AIDS and STIs.

As the tables above illustrate, most district hospitals in the NT2 Project intervention area presently do not have more than one physician. These facilities also do not have “operating theaters”, and in case of serious accidents or injuries, staff currently can only provide simple emergency care, such as cleaning, suturing, and dressing minor wounds, before sending the patient on to the provincial hospital. The same situation pertains to emergency obstetrics. Each year district hospital staff assist with a relatively small number of uncomplicated deliveries. For complicated deliveries, or true emergencies, the patient needs to be referred to the provincial level. It is unknown how many of such cases, in remote villages, simply die at home.

An equally important issue is the lack of routine comprehensive promotive, preventive, and curative outreach clinics geared to up-grade the technical, clinical, and administrative skills of health dispensary workers, while at the same time providing selected health services to the local population. Certain EPI and malaria control activities appear to be the exceptions. As noted in the preceding section the incidence and prevalence of malaria, the malaria case fatality rates, and the slide positivity rates, have all dramatically declined throughout the Lao PDR. This has come about as a result of the distribution and re-impregnation of insecticide treated bed nets (IBNs), the early diagnosis and treatment of suspected and confirmed malaria cases, and the establishment of drug and bed net revolving funds to sustain these efforts. The National Malaria Control Program, supported by many international donors, has made a dramatic impact in reducing malaria morbidity and mortality and thus has directly contributed to improving the overall health status of people living in rural and remote geographic areas. Deaths from malaria have become rare events in Nakai, Nhommalat, and Mahaxay districts; where formally the overwhelming majority of out-patients and in-patients were treated for malaria; and where malaria was always listed as one of the leading causes of death. These impressive results were to a great extent made possible by the efforts of district and village level health workers and volunteers, supported by mass organizations and local village leadership.

3.5 Village and Household Level

But the overall health status of rural/remote communities will only improve once Primary Health Care activities, focusing on the health of women and young children permeate down to the village and household level. Most rural residents, especially ethnic minority men and women, still do not fully understand and appreciate the importance of birth spacing-family planning services in improving the health of mothers, women of reproductive ages, and young children vulnerable to communicable diseases and malnutrition. Similarly they are not aware of the value of regular ante-natal care examinations to monitor the health of the expectant mother and to identify women who are potentially at risk for complicated la-

bor. Likewise communities, and individual families, are not aware of the need for trained birth attendants to assist at the time of delivery and to visit the mother and newborn infant during the immediate post-partum period to provide important health information concerning breast-feeding, immunization, nutrition, and birth-spacing. Educating women on the value of birth-spacing services, and making these services available at the health dispensary and village level, can in a relatively short period of time dramatically reduce maternal and infant mortality; the two most sensitive indicators of a community's health status. One of the key messages that is frequently omitted during training sessions is simply, *"Contraceptives Save the Lives of Women and Infants"!*

4 EXTERNAL ECONOMIC DEVELOPMENT SCENARIOS IN THE KHAMMUANE REGION

4.1 Savannakhet-Khammouane Region Development Plan

In predicting the possible cumulative impacts on health, for different populations living in the NT2 project intervention area, it is essential to foresee to what extent proposed external macro and micro-economic development plans are implemented. In 2001 a series of detailed studies were published suggesting various economic development scenarios for the Savannakhet-Khammouane Region (SKR) which included a three-phased implementation period [i.e. 2001-2005, 2006-2010, and 2011-2020]. The studies proposed that the provincial centers of Savannakhet (Khanthabouly) and Khammouane (Thakhek) strengthen their urban functions as consumption centers, high value added production centers, higher education and training centers, and information centers. Urban town development would be promoted in conjunction with improvements of road networks and the promotion of market oriented agricultural and local industries. Rural center towns would be developed for the tourism and mining industries.

It was suggested that Thakhek be promoted as a gateway for tourism, as well as an industrial city for resource-based manufacturing industries. Its historical buildings would be preserved and renovated, and tourism related facilities would be constructed [especially along the Mekong River]. Mahaxay district center, and to a lesser extent Nhommalat, located near the junctions of Routes 12 and 8B, would become important distribution centers serving the inner land area of Khammouane, as these two road junctions would become major arteries for transporting rural products in Khammouane to domestic and international markets. Nakai, after the completion of the Nam Theun 2 Hydropower Project, would be the site of a large artificial lake envisioned to become one of the major tourist destinations in the SKR. The town of Nakai would become a "mother town" for tourists visiting the lake, as well as the center for a local wood based industry. Boualapha, after the completion of Route 12 would be the closest eco-tourism spot in the region. Hence it was proposed that this town become a tourist as well as a distribution center of local agricultural and handicraft products in the district.

The proposed SKR Development Plan contained several components for major urban-based development initiatives that included, but was not limited to, the following:

- Savannakhet Special Economic Zone (SEZ): The SEZ is to be established adjacent to the new Mekong Bridge to make optimal use of the newly constructed East-West Corridor aimed at linking Thailand-the Lao PDR-Viet Nam. The SEZ will serve multiple functions, including the promotion of logis-

tics (e.g. bonded warehouses, cargo-terminals), processing of export-oriented and resource-based industries, free-markets, and the promotion of the service industry [e.g. hotels, recreation, etc.]. A belt along Route 9, from the Mekong Bridge to the junction of Routes 9 and 13 at Seno [in Outhoumphone District] will be designated as the SEZ. Enterprises in the SEZ would enjoy special investment incentives under a proposed SEZ law.

- Woodworking Industrial Park in Thakhek: A woodworking industrial park is to be established in and around Thakhek; integrating the currently operating small-scale sawmills. It will have a facility for the log auction market, as well as facilities for design, marketing, and testing for wood-processing industries. The furniture industry will also be invited to locate in the park.
- Tourism Free Zone: The designation of a Tourism Free Zone (TFZ) along the East-West Corridor would be an effective mechanism for the promotion of the Lao Tourist Industry in the SKR. It would integrate tourism development and natural/cultural preservation; as well as facilitate the joint promotion of Mekong Tours for international, Thai, and Vietnamese tourists. It could also promote comprehensive tourism management with a one-stop visa control mechanism for international tourists entering the TFZ. The TFZ could serve as a joint training/education site for tourism related human resources in the East-West Corridor, as well as an attractive incentive for Direct Foreign Investment in the Lao tourism industry.

4.2 Tourism

At the present time major destinations for international tourists, visiting the Lao PDR, are Vientiane and Luang Prabang. An increasing number of tourists, however, are going to other sites such as the Plain of Jars (Xieng Khouang), Champassack, Luang Namtha, Bokeo, and Savannakhet. Surveys have indicated that international tourists are mainly interested in seeing nature and observing local life and culture. As such the Lao PDR has, in a relatively short period of time, become an international destination for eco-tourism, rather than ordinary sight-seeing tourism.

Some potential tourism sites identified in Khammoune are:

- The Nakai-Nam Nature Reserve (NBCA): to observe natural forests and mountainous scenery.
- Phou Hinboun National Reserve: to observe spectacular landscapes with limestone mountains, stone forest formations located on the northern edge of the nature reserve [accessible by Route 8A], and natural caves with underground streams.
- Ethnic minority villages: to observe daily life and culture.
- Pha That Sikhottabong: to visit the 29 meter-high stupa built in the 14th century.
- French Colonial Style Buildings in the Center of Thakhek.

4.3 Infrastructure

Long-term and short-term economic plans and proposals are constantly in state of flux. New studies are conducted, keeping in tune with the changing nature of national, regional, and international commercial and political priorities. The Sec-

ond Friendship Bridge, across the Mekong River, connecting Mudahan, Thailand and Savannakhet, Lao PDR, will be an important development in “linking” the Lao PDR to its neighbors and to international markets through the East-West Corridor. The bridge is scheduled for completion in 2006. At the same time the Thai Government has recently publicly stated its intention to support the construction of other bridges across the Mekong River. One would connect Nakorn Phanom and Thakhek, while another would link the northern towns of Chiang Khong and Houay Xay, not far from the so-called “Golden Triangle”; the point where Myanmar, Thailand, and the Lao PDR meet along the Mekong River. A bridge connecting Nathorn Phanom to Thakhek, coinciding with the construction and/or renovation of Routes 8A, 8B, and 12, could in effect create a “mini” East-West Corridor, that would pass through many communities and district towns in the NT2 project intervention area. This bridge would probably be constructed during the period 2010-2020, but depending upon political priorities it could take place earlier.

4.4 Industry

Another interesting recent development concerns the establishment and perhaps expansion of the cement industry in the Lao PDR. The SKR Development Plan identified the cement industry for intensive expansion, based upon the discovery of a large-scale limestone deposit in Mahaxay District. At the present time the Lao PDR imports approximately 90% of its cement requirements from Thailand. Demand by the year 2005 is expected to reach 1.6 million tons; of which 1.3 million tons will be imported. In April 2004 the *Bangkok Post* reported that 8 of Thailand’s largest cement producers have agreed with a Ministry of Commerce request to gradually cut their exports to “zero”, within the next 5 years to reduce environmental impacts in both Saraburi province as well as Thailand as a whole. In 2004 exports will drop from 12 million to 10 million tons. Most of these exports go to the Lao PDR, Cambodia, and Vietnam. Cement exports surged after the “Economic Crisis” of 1997 when local demand dropped sharply and Thai cement producers needed foreign exchange to offset losses caused by the depreciation of the Thai currency. By 1998 cement exports from Thailand totaled more than 20 million tons. Will this recent decision stimulate direct foreign investment of Thai capital and technical know-how to the Lao PDR, to rapidly expand the capacity of the Lao cement industry? Will Mahaxay District be the major beneficiary of this expansion, and if so could this development have a cumulative impact on health for residents of the NT2 Project intervention area?

Another recent development has been an indication from the Thai government that Savannakhet rather than Mukdahan should become the focal point, or “economic hub”, of the East-West Corridor. This could mean a rapid up-grading and modernization of the recently renovated Savannakhet airport to handle an increased number of international tourists and businessmen. It could also result in the construction of a large airport cargo terminal and other related facilities. What effect will such a decision have on the size and composition of the proposed SEZ?

4.5 Future Scenario

To what extent will all of these proposed developments alter current migration patterns in and around the SKR, as well as throughout the country and the neighboring region as a whole? Many of the above mentioned macro and micro-economic developments will commence, or be completed, within the same five-year time frame that the NT2 reservoir, power station, and other infra-structure

inputs are scheduled to be implemented. Others will not reach fruition until a later point in time. Taken as a whole, or even separately, their potential synergistic cumulative impact on health can be considerable for selected communities and populations living in the NT2 Project intervention area. Many of these plans are based on the assumption that the Nam Theun 2 Hydropower Project will harness and provide electricity needed to plan and undertake large-scale economic development initiatives. Another assumption is that a suitable local labor force will be available to participate in these planned developments. Who will comprise this labor force, and from where will these migrants come?

5 MIGRATION AND URBANIZATION IN THE SAVANNAKHET-KHAMMOUANE REGION

5.1 Urbanization in the SKR

At the present time the overwhelming majority of people living in Savannakhet and Khammouane reside in rural settings, where they usually engage in subsistence and small-scale market oriented agricultural activities. The National Census of 1995 indicated that 83% of the population lived in rural areas in comparison to only 17% inhabiting urban centers. Approximately 14% of the population in Khammouane was classified as urban, while the urban population of Savannakhet represented only 15% of total inhabitants. Only Thakhek district, of Khammouane, had a substantial urban population (37%), and the majority of these urban-dwellers were located in or near the provincial center. In most districts of Khammouane, including Nakai, Nhommalat, Boualapha, Xaybouathong, Xebangfay, and Mahaxay urban residents comprised from <1-5% of the total population. The situation in Savannakhet was slightly different, with Khanthabouly (50%) and Outhoumphone (15%) districts having relatively large urban concentrations. But these two districts respectively included the provincial center of the most populous province in the country, and the major junction of Route 9 and Route 13 [at Seno]. All other districts in Savannakhet had urban areas that accounted for <10% of the population. The Lao Reproductive Health Survey of 2000, indicates that urbanization had increased somewhat, during the period 1996-2000, with approximately 1/5 (19.9%) of the population now living in urban areas, while the remainder (80.1%) still continued to reside in the countryside. In Khammouane urban population now represented 22.4% of the total population, while the figure for Savannakhet had increased to 17.1%. Surprisingly Khammouane had now become the 3rd most urbanized province in the country, only following Vientiane Municipality (61.4%) and Luang Namtha (25.0%). Savannakhet's urban population was ranked 8th in the nation. The above-mentioned macro and micro-economic development scenarios, however, suggest that this situation can easily change in a relatively short period of time and that rapid urbanization and large-scale migration may soon become major issues for the two largest provinces in the Central Region.

5.2 Migration in the SKR

Populations in transit, for temporary or permanent purposes, are ideal focal points for the transmission of disease. This can mean new diseases with which local residents and health personal have little knowledge or experience [e.g. HIV/AIDS], or the re-introduction of health problems previously brought under control [e.g. malaria]. Not all migration is external. The new economic opportunities, and/or conditions, emerging from the construction of the NT2 Project and

other macro and micro-economic initiatives identified for the SKR can easily induce a considerable internal migration from remote mountainous and rural areas into the district towns, alongside major roads, or near construction sites. Large-scale unplanned and uncontrolled migration will complicate the health situation in the NT 2 Project intervention area, and potentially put a tremendous strain on the existing health care delivery system. The establishment of a NT2 Project polyclinic, with professional personnel employed to take care of the immediate health needs of NT2 Project staff, workers, and their families will alleviate some of these problems. A number of important health issues, however, may be beyond the capacity of the project or the local health care delivery system to effectively address, unless they are anticipated well in advance and appropriate plans and measures put into action before the situation has reached a critical level.

Although it has been suggested that the GOL prohibit the movement of families to accompany 4,200 construction workers to campsites in the NT2 Project intervention area, such a ruling may be impractical or impossible to enforce. Recent anecdotal and documented information indicates that there already are a huge number of Lao young men and women on the move, migrating to areas with perceived better economic opportunities. As such it may be useful to review current labor migration patterns in Khammuane and Savannakhet province. Since the early 1990s a number of factors have conspired to increase the migration of population in the Lao PDR. The opening of borders, the impact of globalization, market demand, widening economic differentials within and between countries, and the growing transnational organized crime and illegal labor recruitment networks have each acted to increase migration. Other factors including natural disaster, unbalanced population growth and strains on education and employment opportunities have also stimulated an increase in both legal and irregular migration—internal and cross-border—as “vulnerable” populations try to improve their life opportunities elsewhere.

5.3 Survey: “Labour Migration”

In 2003 the Ministry of Labour and Social Welfare, Department of Labour, with support from the Committee for Planning and Co-operation, National Statistical Center, conducted a large survey dealing with “labour migration” from communities in Khammuane, Savannakhet, and Champassack. The survey included a total of 6,000 households containing 37,200 people, residing in 300 villages. Four separate questionnaires were included in the survey to obtain information from heads of households, children aged 10-17 years, youth aged 18-25 years, and for returned migrants. The preliminary survey report also included baseline data of Lao migrant workers in Thailand, which was provided by the Ministry of Labour, Thailand.

Some of the highlights of the survey include the following:

- Of the 2,526 individuals who had migrated from their homes, 80.8% migrated overseas. With respect to male migrants, 4.9% migrated inside their district, 4.8% migrated to other districts, 9.5% migrated to other provinces, and 80.8% migrated to other countries. With respect to female migrants, the percentages were slightly different, with more females migrating to other countries. The figures for females included those migrating inside their district (3.5%), to other districts (3.0%), to other provinces (7.5%), and to other countries (86.0%). These figures indicate that the overwhelming majority of migrants perceived that there were better economic opportunities overseas than at locations closer to their respective homes.

- With respect to migration to other countries, Khammouane had the lowest percentage of migrants [44.7%]. This included 61.3% of the female and 32.4% of the male migrants. This was considerably different than Savannakhet, where 87.7% of all migrants went overseas [i.e. 91.0% of females and 83.2% of males]. In Champassack 71.5% of all migrants went overseas [i.e. 75.1% of females and 67.7% of males].
- With respect to the origin of migrants who went overseas, the survey did not indicate home-district, but rather disaggregated data into three distinct categories, which included urban, rural with roads, and rural with no roads. Regardless of their geographical origin, the vast majority of all migrants went overseas. With respect to those originating from urban areas 87.3% went overseas. This included 91.3% of all female and 82.4% of all male migrants originating from urban areas. Of those migrants who came from rural areas with roads, 75.9% went overseas (i.e. 82.3% of all females and 67.8% of all males migrating from this zone). Of those migrants who originated from rural areas without roads 88.0% went overseas (i.e. 89.7% of all female and 85.5% of all males migrating from this zone).
- Thailand was the main attraction for migrants going overseas [81.5%]. Very few went to Europe [0.5%], while the remainder primarily went to other Asian countries [8.3%] or the USA [9.3%]. Although migration from the Lao PDR to Thailand started many years ago, approximately $\frac{3}{4}$ [73.7%] of the migration to Thailand, took place during the past four years [2000-2003]. These figures suggest that the pace of migration has increased in recent years, and that the potential for future migration, whether domestic or internal, is a well-entrenched phenomenon that may not be subject to governmental attempts at control.
- With respect to how migrant workers fared in Thailand, heads of households were asked whether they had received information concerning the livelihood of household members currently working in Thailand, and whether these individuals could be contacted. The results indicated that 67.5% of migrant workers [i.e. 63.2% of males and 70.6% of females] apparently had no problems and were satisfied with their working conditions. A much smaller percentage of migrant workers [3.4%] indicated some problem or hardship [i.e. 3.9% of males and 3.1% of females]. A potential source of concern, however, was the fact that 29.1% of migrant workers [i.e. 32.9% of males and 26.3% of females] have not sent back any information to their families, nor has anybody in their community received information about their fate or whereabouts. The last series of figures is somewhat troublesome as they may indicate that children, adolescents, and youth have been lured to work overseas, and are now employed in occupations that expose them to physical, emotional, or health risks.
- Of the cohort who did not send any information to their families, the survey suggested a possible correlation between socio-economic status (SES) as well as ethnicity. Of those households listed as being in the lowest 20% SES group, 60% of the migrant workers did not send home any information. For the lower-middle 20% SES group 42.1% of migrant workers did not send information home. For the middle 20% SES group 29.5% did not send home information. For the upper-middle 20% SES group 19.6% did not send home information, while for the highest 20% SES group only 13% did not send home any information. With respect to ethnicity only 27.3% of the Tai-Kadai Group did not send home any information, while for the Austroasiatic Group this fig-

ure was 49.3%. Similarly with respect to place of origin, only 15.4% of those originating from urban areas did not send home any information, compared to 21.9% from rural areas with roads, and 31.1% from rural areas without roads. The provincial breakdown of migrant workers not sending information back home to their families were as follows: Khammouane (43.9%), Savannakhet (32.1) and Champassack (15.4%).

- The above mentioned topic was included in the survey to determine whether “migrant workers are at high risks of being victims of trafficking”, with the assumption that “migrant workers” who have not contacted their head of household, have not sent any information about their livelihood, nor sent any remittances since leaving their village at least a year ago” are a high risk group. Interpreting the data is a little more complex, as there can be other reasons why migrant workers do not contact their families or send remittances home. Two of the most logical causes may be that this cohort contains a large percentage of individuals who are illiterate, or functionally illiterate, and/or whose family members cannot read or write. This cohort may also live in remoter areas of KM/SVK/CPX where routine and reliable mail service is not available, and/or where it may not be safe to send money/remittance through the postal system. This interpretation would correspond to the fact that those having no contact with family members are more commonly found in rural areas without roads, where socio-economic status is very low, and where there are a greater concentration of Austroasiatic ethnic groups. This interpretation should not, however, reduce concern that many migrant workers may indeed be the victims of trafficking, and that effective programs to address this issue need to be established immediately.

5.4 Migration to Thailand

In 2001 and 2003 Thailand attempted to register all foreign migrant workers. The Minister of Labour/Thailand shared this information with the Ministry of Labour and Social Welfare/Lao PDR. The data does not indicate what percentage of Lao migrant workers, in Thailand, actually registered. Nor does it suggest what percentage of migrant workers, from the Lao PDR, had legal work permits. The registration process was established to extend work permits for a 6-month period. The first phase of registration was completed from 24 Sept to 25 Oct. 2001. The second phase was conducted from 24 Feb. 2003 to 25 March 2003. In the first phase a total of 59,358 Lao migrant workers registered [25,771 male and 33,587 female] in 10 categories of permitted work. The registration fees for the first registration cost 3,250 Baht [for health insurance, work permit fee, ID card, and repatriation fund]. During the second round of 6-month work permit extensions only 42,186 Lao migrant workers registered. The registration fee was 1,200 Baht. Only those migrant workers who registered during the 1st phase were allowed to register for the 2nd phase of work permit extensions. The report suggests that the large decline in Lao migrant worker registration, during the 2nd phase, may have come about because individuals changed employers, or they did not wish to pay the registration fee.

Of the 59,358 Lao MW in Thailand who registered for 1st phase, the following table illustrates the type of occupation according to gender:

Table 4: Percentage of Migrant Workers According to Occupation and Gender.

Type of Activity	Male	Female	Total
------------------	------	--------	-------

Agriculture	3,951 (6.7%)	1,750 (2.9%)	5,701 (9.6%)
Mining	32 (0.1%)	16 (0.0%)	48 (0.1%)
Pottery	139 (0.2%)	41 (0.1%)	180 (0.3%)
Construction	1,479 (2.5%)	654 (1.1%)	2,133 (3.6%)
Rice Mill	89 (0.1%)	40 (0.1%)	129 (0.2%)
Animal Husbandry	2,630 (4.4%)	887 (1.5%)	3,517 (5.9%)
Fishing	1,720 (2.9%)	382 (0.6%)	2,102 (3.5%)
Porters in Warehouses	676 (1.1%)	223 (0.4%)	899 (1.5%)
Domestic Workers	1,521 (2.6%)	15,307 (25.8%)	16,828 (28.4%)
Special Activities with Employers	11,621 (19.6%)	11,993 (20.2%)	23,614 (39.8%)
Special Activities Without Employers	1,913 (3.2%)	2,294 (3.9%)	4,207 (7.1%)
Total	25,771 (43.4%)	33,587 (56.6%)	59,358 (100.0%)

One of the serious drawbacks in trying to analyze this data concerns the fact that two of the ten categories are very vague. This includes “special activities with employer” and “special activities without employer”. “Special activities with employers” represents the largest occupation for males, the second largest occupation for females, and the largest category for all Lao migrant workers. One wonders whether this category includes people working in the entertainment sector or commercial sex industry, or in factories with poor working and/or living conditions conducive for physical and mental abuse and/or which promote the trafficking of women and children.

Table 5: The Residence/site of Work of Lao MW in Thailand According to Region.

Province/Region	Male	Female	Total
Bangkok	33.7	49.6	42.7
Central Region	21.1	17.5	19.1
Eastern Region	17.7	8.4	12.4
Western Region	3.3	1.9	2.5
Northern Region	3.0	1.6	2.3
Northeastern Region	12.9	17.9	15.7
Southern Region	8.3	3.0	5.3

The distribution of Lao migrant workers in Thailand, by geographic region, is consistent with economic opportunities in the country. Hence it is not surprising that most migrant workers were concentrated in Bangkok, the Central, and the Eastern Regions. The Eastern Region has many factories while the Central Region is the major agricultural producing area of the country. The large number of Lao migrant workers employed in the Northeast tend to be distributed in provinces adjacent or close to the Mekong River and/or directly across from Khammouane, Savannakhet and Champassack. Lao migrant workers in the South probably account for those employed by the fishing and related canning industries.

The age of migrant workers is relatively young. More than one-third (38.4%) are 20 years of age or younger, while almost three-quarters (72.5%) are 30 years of age or younger.

5.5 Future Migration Trends

The fact that the migrating population comprised 6.9% of the total sample population, in Khammouane, Savannakhet, and Champassack, suggests that a huge number of people are in the process of migrating from their homes in search of employment and/or educational opportunities. As new economic opportunities are created by the NT2 Project, and other macro and micro-economic development initiatives outlined in the preceding section, it is conceivable that the pace of migration may dramatically escalate, and that migration patterns may substantially change within the next 5-10 year period. This may mean that more migrant workers eventually seek employment opportunities closer to their village of origin. This scenario can have a profound effect on health throughout the Lao PDR, but especially in selected “hot spots” where new types of behavior, different living conditions, and a close mingling amongst previously separated socio-economic and ethnic groups will come into play.

Escalated and expanded levels of migration, especially among adolescents and youth migrating from rural to urban areas, can exert a profound influence on the demographic composition of communities and future population growth rates. These new migration patterns could also radically impact on traditional socio-economic and emotional support systems that sustain rural life, or ensure that linguistic and cultural traditions [including the use of herbal medicines] are passed from one generation to the next. These factors are often overlooked or given a low priority when designing national or regional level long-term economic development plans.

6 PREDICTION OF CUMULATIVE IMPACT

6.1 The 5 Year Scenario

If we were to gaze into a crystal ball, what would the NT2 Project intervention area, as well as adjacent geographical regions, look like in 2010? Would traffic be flowing across the two new Mekong River bridges connecting Savannakhet and Mukdahan as well as Thakhek and Nakorn Phanom? Would large and small factories, restaurants, petroleum stations, entertainment venues and small businesses be blossoming on both sides of the 30 kilometer-long Special Economic Zone, extending from the Mekong River Bridge at Savannakhet to the junction with Route 13 at Seno? Would the East-West Corridor become, in effect, one long stretch of small shops, guest-houses, restaurants, bars, markets, and perhaps new communities providing goods and services to long-distance truck drivers, businessmen, and tourists traveling between Thailand, the Lao PDR and Vietnam? Would the expanded and modernized airport in Savannakhet facilitate a dramatic boom in local and regional tourism, as well as serve as a major outlet for Lao exports? Would Savannakhet, in fact, have started to challenge Vientiane Municipality as the nation’s commercial and economic center?

Would the waterfront area of Thakhek have been transformed into a major tourist attraction featuring French colonial architecture? Would the district towns of Nongbok, Xebanfai, Hinboun, Mahaxay, Nhommalat, Nakai, and Kamkeut [in Bolikhamxay] have grown from large villages or tiny towns into true urban areas serving their respective hinterlands as outlets for agricultural and local handicraft

products, small and large-scale manufacturing centers, and take-off points for nearby eco-tourism? Would the limestone quarry near Mahaxay have been transformed into the nation's largest producer of cement? Would the reservoir and power station created by the NT2 Project begun to produce electricity for domestic consumption as well as for export to Thailand? And would the new lake created by the NT2 Project have already started to attract international and domestic tourists?

Do we need to clean our crystal ball? Are any, or all, of these scenarios likely to take place within the next 5-year period? If the pace and scope of economic developments in other parts of the Lao PDR, such as Luang Prabang, Oudomxay, Xieng Khouang, and Muong Sing (Luang Namtha), can serve as a realistic gauge, then much of what has been conjured up by our crystal ball can easily exist by 2010. Such dramatic changes, however, will have both positive and negative aspects, which can impact on the physical, mental, and environmental health of communities and individuals. Who, for example, will serve as the labor force to construct the roads, bridges, factories, hotels, restaurants, and other infrastructural inputs outlined above? From which locales, or even countries, will these workers originate? Once construction is completed, who will operate and maintain these facilities or sites? Will migrant workers opt to return to their "original" homes or remain in their new places of residence? Will those who decide to remain, frequently or periodically travel to their original homes to spend time with their families, spouses, and community members? Will these new urban centers attract a continual stream of migrants from the rural hinterlands to serve as an ever-expanding labor-force?

How will the pace of urbanization, in the district centers of Nakai, Nhommalat, Mahaxay, Xebangfai, and Nongbok proceed? Will it be gradual or quite abrupt? Will there be any town planning? Will homes be neatly spaced along lanes lined with fruit or shade trees, or merely constructed and laid-out in any haphazard manner, one on top of the other? Will crowded and new living conditions promote the transmission of vector-borne diseases such as dengue fever [and DHF]? Will municipal authorities have the resources to construct appropriate and adequate water supply and human-commercial-industrial waste disposal systems? Which agencies will be responsible for monitoring environmental and industrial sanitation conditions? Which agencies or individuals will oversee food safety issues in the local markets? Similarly who will monitor pharmaceutical and medical safety issues in private pharmacies, drug shops, and clinics?

Which agencies will promote traffic safety and enforce traffic regulations? Will there be any traffic lights or traffic signs in these new urban areas, or will large trucks, cars, vans, motorcycles, and bicycles simply compete for available space on the roads and individually determine their own speed levels? Will municipal authorities have adequate resources to maintain roads? Vehicular accidents, causing death, disability, and injury have already reached epidemic proportions in many parts of southeast Asia, and are rapidly becoming a leading cause of morbidity and mortality in the Lao PDR. By the year 2020 WHO estimates that there will be 2.3 million vehicular accidents occurring annually. This would rank as the third most important cause of death globally. Are local health facilities prepared to treat victims of serious vehicular accidents, and are local authorities ready to establish vehicular accident safety programmes?

The above-mentioned scenarios also indicate that within a very short period of time, many communities in what were relatively isolated areas in the Central Region of the Lao PDR, may be in close proximity to cross-border transportation

networks. In addition to the East-West Corridor in Savannakhet, new road networks in or adjacent to the NT2 Project intervention area [i.e. Routes 8A, 8B, and 12] will link villages in Mahaxay, Nhommalat, Nakai, Hinboun, Boualapha and Khamkeut districts with Vietnam and Thailand in a matter of hours. With new roads being constructed across the border in Vietnam [the Ho Chi Minh Trail], and the proposed bridge crossings at Savannakhet and Thakhek, there is a grave danger that improved cross-border transportation can escalate the momentum and flow in trafficking local women and children, especially from ethnic minority communities. Cross-border transportation networks, and the movement of large numbers of people, can also serve as a convenient means of increasing communicable disease transmission. This is especially relevant for HIV/AIDS and STIs, but can include SARS as well as many other illnesses.

How will the GOL, the NT2 Project, international assistance agencies, and the private sector deal with the provision of health services over the next 5-year period? Will factories, hotels, and other sites establish their own network of clinical and counseling services, or will they decide to provide or subsidize workers with various health insurance schemes? Will there be a mushrooming of private clinics, pharmacies, and drug shops serving the needs of workers, local residents, and those passing through the region? Who will monitor and regulate these facilities? Will government funds be made available for the expansion, renovation, and/or new construction of provincial and district hospitals? At the present time residents of the NT2 Project intervention area are primarily served by a health care delivery system that consists of district hospitals and health dispensaries. These facilities generally have limited supplies of medical supplies and equipment, and existing manpower do not have the pre-requisite competency-based skills to address many current health issues and problems. As such monthly in-patient and out-patient caseloads are low. The district hospitals do not have operating theaters, making it impossible to treat any serious accident or injury, or to provide emergency obstetrical care. These facilities also contain very few highly trained clinicians, laboratory technicians, and public health specialists needed to address existing and/or new health problems that can result from the influx of large numbers of construction workers and migrant laborers settling in and around the NT2 Project intervention.

The Ministry of Health-World Bank "Health Services Improvement Project" (HSIP) will try to address some of these issues, during the period 2004-2009, but the project mandate covers only 30 of the poorest districts in the 8 southern-most provinces extending from the Xaysomboun Special Region down to Attapeu. It includes Khamkeut and Nakai Districts. The HSIP is viewed as a means to foster an integrated district health development approach, assisting district health teams to better plan, manage, and monitor health care delivery in their respective geographical areas. The HSIP will focus efforts on capacity building, development of human resources, health planning and management, and sustainable health sector financing. Some funds will be available for civil works renovations and improvements at selected district hospitals, to allow for a wider range of comprehensive health services. The HSIP, and other routine inputs from the MOH, will not necessarily dramatically increase the number of health dispensaries in the NT2 Project intervention area, nor increase the number of local health personnel.

A key issue is not necessarily who will provide health care to residents, construction workers, or migrant workers in the NT2 Project intervention area, as well as at various locales in the East-West Corridor, the Sunset Corridor, and the new urban centers. It is rather who will closely work with and teach new *vulnerable*

groups basic life-skills that can promote good health and prevent unnecessary illness and death. Maps included in the “Labour Migration Survey in Khammouane, Savannakhet, and Champassack 2003” illustrate that sample villages included ethnic minority communities located in the NBCA, on the Nakai Plain, in the Nam Theun-Nam Kading-Nam Hinboun Basin areas, as well as sections of Nhommalat, Boualapha, and Mahaxay districts. These maps also pinpointed sample lowland communities in Thakhek, Hinboun, Nongbok, Xebangfai, and other geographic areas of the province included in the study. As mentioned above, the survey found that almost 40% of the migrant workers [i.e. 38.4%] were 20 years of age or younger. How many individuals in this cohort understand the importance of following good personal hygiene practices to prevent illness, or the risks associated with certain behavior that can lead to serious vehicular accidents or the transmission of STIs and HIV/AIDS? Do they know what precautions to take to minimize potential health problems or where to receive information, counseling, and appropriate medical services? What percentage of young women in this cohort, for example, could successfully negotiate safe sex skills including consistent use of condoms with casual or regular partners and/or clients? [i.e. in the case of commercial sex workers]?

The Lao PDR is considered a *low prevalence* HIV/AIDS country. But is this the actual situation? As of March 2004 of the 98,016 blood samples tested, only 1,212 (1.2%) were HIV positive. Of this number 670 individuals were diagnosed as having AIDS, while 486 individuals died from AIDS. The distribution of HIV positive cases, between 1999-2003, has remained relatively constant, annually fluctuating between 152 and 170 cases. The distribution of HIV cases progressing to AIDS has also remained constant between the years 1999-2003, fluctuating between 93-110 cases per year; while the distribution of AIDS deaths has remained constant between the years 1997-2003, with 62-67 annual mortalities. But what is the source of this data, and does it possibly conceal a much more explosive HIV/AIDS situation lying below the surface?

Although the National Committee for the Control of AIDS (NCCA) has conducted a series of first generation “biological” sentinel surveillance surveys, and more recently launched a second generation of “biological” and “behavioral” sentinel surveillance surveys, there is not any active surveillance mechanism to regularly test “high-risk” and “normal” populations to better gauge the prevalence and incidence of HIV/AIDS. Prevalence meaning the actual number of HIV/AIDS cases existing at a particular point in time, while incidence pertains to the number of newly discovered HIV/AIDS over a finite point in time [e.g. one year]. Most of the existing data derives from “passive surveillance” which are reports sent to the NCCA by provincial health offices. This includes blood samples tested as part of the screening procedures to determine whether donated blood is contaminated with certain pathogens [e.g. HIV/AIDS, certain STIs, Hepatitis B, C, E, etc.]. The data also includes special investigative blood tests of patients who do not recover from prescribed clinical treatment. Blood is collected and examined anonymously, and unless an individual specifically requests the results of the blood test, nobody is informed or counseled about their HIV status.

Anecdotally it appears that the vast majority HIV positive cases, or those progressing to or succumbing to AIDS, had previously worked in Thailand or were spouses of people who worked in Thailand. Thus it is not surprising that the largest number of known HIV positive cases come from Savannakhet (535), Vientiane Municipality (325), Khammouane (95), Champassack (94), and Bokeo (77). Provinces located along the Mekong River adjacent to Thailand. The age distribution of HIV positive cases, between 1990-2003, is principally concentrated in

young adults; with the age cohort 25-29 years having the highest levels, followed by those in the age groups 30-34 years, 20-24 years, and 35-39 years. Precisely the age cohorts that tend to seek employment opportunities in Thailand, and who may decide to return home once they became ill. The gender distribution of known HIV/AIDS cases, during this same time period, is 62% male and 38% female. Heterosexual interactions (82%) is the most prevalent means of transmission, followed by mother-to-child-transmission (2.5%), bisexual interactions (0.8%), blood transfusion (0.4%) and injection (0.3%).

It should be noted that none of the district hospitals in Khammoune have the reagents or the technical training needed to perform HIV serological tests. Health staff have not been trained to counsel HIV positive or AIDS patients, and/or their spouses and immediate family members. Nor have they been trained in the clinical management of AIDS related opportunistic infections, or the provision of HAART (highly active anti-retroviral therapy). These are specific interventions that not only prolong and improve the quality of life for AIDS patients, but also prevent AIDS patients from dying. HAART has dramatically reduced the morbidity and mortality rates for HIV/AIDS in all “developed countries” over the past 7-8 year period. HAART has recently been introduced, on a much more limited basis, in many “developing countries” where it has demonstrated the same impressive results in reducing morbidity and mortality rates associated with HIV infected individuals.

The NCCA included Khammouane, along with Savannakhet and Oudomxay in the ADB sponsored “Community Action for Preventing HIV/AIDS Project” in order to prepare national and local authorities for a potentially explosive HIV/AIDS situation once the NT2 Project commenced. In addition to these three provinces in the Lao PDR, the project also included selected geographical areas of Cambodia and Vietnam.

The project’s main objectives consisted of the following:

- to support a comprehensive set of HIV/AIDS prevention activities in strategically important areas [i.e. “hot spots”] for the transmission of HIV in the region, and
- to strengthen the capacity of national and local HIV authorities and selected NGOs to develop community based prevention and care programmes.

Within provinces the project focused on (1) sites and areas that receive many transient mobile populations or long-term migrants, (2) large construction sites, and (3) source communities for migrants. The project had three components: (1) community-based HIV prevention activities, (2) behavior change communication, and (3) condom promotion. There was also a component to provide care and management of Sexually Transmitted Infections (STIs).

The preceding section has focused on potential cumulative impacts on health caused by economic development, especially urbanization, industrialization and migration. Other cumulative health impacts, directly resulting from NT2 Project interventions affecting irrigation and water supply and sanitation, will be described and dealt with during the review of the specific impact zones.

Rather than discuss all of the potential scenarios, the CIA will make two assumptions. The first is that the “Health Action Plan” included in the recently completed

“Health Impact Assessment” (Chapter 18 of the Nam Theun 2 Hydroelectric Social Development Plan) will be implemented wherever feasible and practical. The second assumption is that the specific environmental management measures outlined in the “Environmental Assessment for Construction Phase Activities, Information Prepared by Turnkey Contractor” dealing with runoff-control, noise control, dust control, waste control, and rehabilitation will also be implemented wherever feasible and practical.

6.1.1 *Nakai Plateau and Nakai – Nam Theun NBCA*

The Nakai Plateau and NBCA contains at least five distinct, but interacting, populations that will be directly affected by the NT2 Project. They include the following:

1. The approximately 5,500 ethnic minority inhabitants of the NBCA who reside in 30 scattered villages situated along the tributaries and source of the Nam Theun River.
2. The approximately 5,700 ethnic minorities whose homes will be inundated by the reservoir and who will be resettled in 13 new communities on the Nakai Plateau. A small number of the original group will be relocated to Khamkeut District (Bolikhamsay) near the district center of Lak Sao.
3. The approximately 1,500-2,000 present inhabitants of the Nakai district center, whose numbers can potentially multiply several-fold as camp followers and other migrants converge on this locality to provide goods and services for construction workers, government officials, and others during the five-year construction period.
4. The approximately 4,200 construction workers who will work in the following 12 camps: the Nakai Dam Area Construction Camp (1), the Oudoumsouk Work Camp Zone (2), the Power Station Work Camp Zone (4), and the Downstream Work Camp Zone (5). Most of these camps are actually located below the Nakai Plateau, but it is more appropriate to include them in this geographical section than in that designated as the “Xebangfai Basin and Surrounding Districts Zone”.
5. The present inhabitants of the Nhommalat district center, whose numbers can also multiply several-fold as camp followers and other migrants converge on this locality to provide good and service for construction workers, government officials, and others during the five-year construction period. Being located at the junction of Routes 8B and 12, the district center will also be affected by cross-border commerce and tourism between the Lao PDR and Vietnam, and perhaps Thailand as well. The Nhommalat district center is actually located below the Nakai Plateau, but it is more appropriate to include in this geographical section than in that designated as the “Xebangfai Basin and Surrounding Districts Zone”.

The NCBA: This area stretches from the foothills adjacent to the Nakai Plateau up through the mountainous forests bordering Vietnam. These communities are generally considered outside the range of actual or potential effects of the NT2 Project, as they are situated above the plateau, and far away from the various construction sites, worker camps, and resettlement villages. This does not mean, however, that health conditions in these communities will not be affected during the initial five-year construction phase or at different periods during the operation of the NT2 Hydropower Project. A great deal will depend upon to what extent community members voluntarily decide, or are forced by external circumstances,

to interact with populations living, and developments taking place, on the Nakai Plateau. The NBCA represents one of the more isolated geographical areas in Khammouane. It has few health dispensaries, and villagers have limited access to appropriate health care services during times of emergency or serious illness. It is a geographical area where women and young children are most vulnerable to potential life-threatening illnesses or conditions.

There are several realistic scenarios that will take place with respect to the NBCA. The first is that its ethnic minority inhabitants will have minimal interaction with other populations and events taking place on the Nakai Plateau. Villagers will continue to visit relatives and co-tribesmen in communities scheduled for resettlement, and occasionally visit the district center to sell forest products and to buy essential household commodities. Very few members, however, will actually migrate to the Nakai Plateau or to other geographic areas participating in macro and micro-economic developments [e.g. the East-West Corridor]. This will mean that the NT2 Project, and other external developments, should exert a limited impact on health in the NBCA. Health status can improve if more and better trained health personnel are deployed to existing health dispensaries, or if district hospital and health office personnel make more frequent outreach visits, and/or conduct regular in-service training opportunities for health dispensary workers, TBAs, VHVs, and village malaria workers. There is a greater chance, however, that the district health team will soon become pre-occupied addressing new health issues and problems caused by a burgeoning population in and around the district center, as well as by providing increased supervisory and outreach services to the communities scheduled for resettlement. Under this scenario the precarious health situation for women of reproductive age and young children in the NBCA may actually deteriorate.

The second scenario is that inhabitants of the NBCA will have medium level interaction with other populations, and events taking place on the Nakai Plateau. This may include families wishing to move closer to their co-tribesmen once they observe the newly constructed resettlement communities and other social services associated with this development. Others, perhaps including adolescents and young adults, may be attracted to the district center or to ad-hoc settlements springing up near construction camp sites, where they can be employed in a wide range of occupational pursuits. Those finding employment will be able to financially support their families, and this may bring about improvements in health. On the other hand some of these new migrants may be lured into activities which put their health at-risk. Some may be forced to work long-hours and not fed properly, while others may be induced to engage in sexual activities that put them at risk for STIs and HIV/AIDS. For those who cannot successfully find employment locally, there is the chance that they may be encouraged to seek work further from their homes; in one of the nearby district towns, in factories/establishments in the SEZ or the East-West Corridor or in Thailand. The further one moves from home, the greater the chance of being caught in the web of trafficking activities which can have serious consequences on physical and mental health. There is, of course, a plus side to moving to the district center. Migrant workers from the NBCA may have access to more food as well as more nutritious meals. They may also be less exposed to certain communicable diseases and adverse health conditions. And they may have better access to emergency and/or routine health care provided by the district hospital, private clinics, pharmacies or drug shops.

The third scenario is that by 2010 a large number of people inhabiting the NBCA have decided to migrate elsewhere. This may include entire communities, individual households, but more than likely it would consist of specific age groups.

This exodus would probably include many adolescents and young adults, who are not as spiritually or emotionally tied to their communities. Many may also feel that it is easier to earn a living in some urban setting than to eke out a very difficult existence on upland paddy fields or gathering forest products near their homes. Most of this cohort would probably initially try to find work in and around Nakai, but their numbers may be too high to absorb, or they may have learned from co-villagers that better opportunities exist in the lowlands along the East-West Corridor or across the Mekong River in Thailand. Not having acquired many “life skills” outside of their remote villages, these young men and women will be particularly vulnerable to becoming part of an “under-class” of workers surrounded by poor working and living conditions, or being trafficked for illegal purposes that will put their health at risk. Many migrant workers will obviously find their new lives a great improvement over what they previously experienced in remote villages. Some will find life-partners, settle down, and establish families. Others will become disoriented and alienated in unfamiliar or hostile environments. This may lead to depression, alcohol or drug abuse, or other destructive anti-social behavioral problems. Depending on individual circumstances a certain percentage of this migrating cohort will be exposed to STIs and HIV/AIDS. Lacking proper understanding about the nature of these illnesses, or how they can be treated or prevented, may inadvertently lead to horizontal or vertical transmission of HIV/AIDS to one’s spouse or newborn infant. For those remaining in the NBCA life will become more difficult. There will be less adolescents and young adults able to share the burdens associated with subsistence farming and gathering. Many of the elderly, who may also be responsible for taking care of young children, will be under physical and emotional stress. This may be exacerbated by the fact that some of their grown children do not send home any news about their new lives and/or any remittances necessary for the family’s daily survival. Accordingly a certain percentage of those remaining in the village may become depressed.

The Resettlement Communities: Seventeen ethnic minority communities, currently residing on the site of the proposed reservoir, will during the 5-year construction phase be resettled. For many of these communities resettlement involves a relocation of less than 5 kms from their present homes. This move, however, may represent quite a momentous change in their daily life-styles. On the surface the health status of ethnic minorities, participating in the resettlement scheme, should substantially improve if the pilot village of Nong Boua is a representative “model” of what will eventually take place. New housing design should have a positive impact on general health conditions. All households will be resettled into a relatively spacious home, containing separate living and cooking areas. The homes are designed to reduce rain and cold weather from entering the premises, as well as to promote better cross ventilation. Each home is elevated off the ground; which will reduce direct or close human contact with many types of insects, rodents, reptiles, and other animals that can potentially cause illness. Water and environmental sanitation conditions will dramatically improve. Each home will have its own source of safe potable water for drinking and household use, as well as a water-seal latrine. The latrine site is large enough to use as an enclosed bathing area, and this should promote a higher level of personal hygiene. These two innovations, if used and maintained properly, should dramatically reduce the prevalence and incidence of water-borne diseases and intestinal parasitic infections, one of the leading causes of morbidity and mortality on the Nakai Plateau. Each household will also be provided with insecticide treated bednets which, if properly maintained, used and re-impregnated, will reduce the prevalence and incidence of malaria as well as infestations and illnesses caused by mosquitoes, lice, bedbugs, and fleas.

The project will support the construction of approximately 3 new health dispensaries to cater to the health needs of the resettlement communities. Each health dispensary will serve 3-5 communities, depending upon the population size of the “catchment area” and traveling distance to the health facility. A system of regular mobile supervisory teams, from the district hospital and district health office, will provide technical and logistical support to the new health dispensaries as well as specific health services to the target population. As each resettlement village will be connected to Route 8B, by a small feeder road, villagers will be able to more conveniently travel to the district hospital in times of emergency. The project will also provide support for the establishment of irrigated rice-fields, horticulture production, and other occupational training and extension services to residents of the resettlement communities. These interventions should increase food production and allow families, especially women of reproductive age and young children, to have access to more nutritious and well-balanced diets. The project anticipates that resettlement communities will be able to market their horticultural products in the Nakai district center as local demand increases with the influx of construction workers, camp followers, and other migrants settling in and around the Nakai Plateau.

The resettlement of communities rarely materializes as originally planned. There are usually many unforeseen forces that can interfere or disrupt this process. A major issue, raised in several of the NT2 Project documents, concerns the quality of the soil in the resettlement area. Will it, even with irrigation, produce the expected rice and horticultural yields? Will insects, rodents, and other pests destroy part of the crop? Will farmers, even against the advice and support of agricultural experts and extension workers, decide within a relatively short time to use pesticides and herbicides to maintain or increase production levels, which at the same time put producers and consumers at risk to a number of serious health problems? Will these pesticides and herbicides be properly stored, or will they be indiscriminately kept in and around the house, in easy reach of young children? Will the runoff from pesticide use eventually reach nearby streams and other waterways used by people outside the resettlement communities?

Another issue of potential concern, is the extent to which people in the resettlement communities will interact with other populations, and developments taking place on the Nakai Plateau. Although they have been considerably less isolated than many of the communities in the NBCA, villagers will now be in greater proximity to the district center, as well as ad hoc settlements that may emerge near camp sites. Will this development encourage a significant number of resettlement community members, or perhaps specific age groups such as adolescents and young adults, to seek employment outside their villages? What is the NT2 Project’s policy on hiring “local people” for unskilled tasks as construction workers, cleaners and sweepers of dormitories, kitchens, canteens, etc.? Will more and more adolescents and young adults venture on into town during the agricultural off-seasons and eventually find employment in restaurants, market places, shops, or entertainment venues serving a large work and migrant labor force? Will some of these individuals, originating from the resettlement communities, eventually decide to seek their fortunes in the Nhommalat or Mahaxay district centers, and/or gradually further away along the East-West Corridor or in Thailand? The “Labour Migration Survey in Khammoune, Savannakhet, and Champassack 2003” indicated that survey villages included communities from the Nakai Plateau and NBCA. Is migration already an aspiration of many adolescents and young adults, and if so to what extent will urbanization and the NT2 Project accelerate this process?

The Nakai district center, as well as ad hoc settlements that may spring up near camp sites, may potentially become major focal points for the transmission of STIs and HIV/AIDS. The district hospital has, over the past year, begun to see and treat more STI cases, but these relatively small numbers may only represent the tip of the iceberg, as local people are embarrassed and accordingly seek treatment at private pharmacies or tiny drug shops. Knowledge and understanding of the dynamics involved in transmitting and preventing STIs, and HIV/AIDS, still remains low amongst many at risk individuals. Will adolescents and young adults from the resettlement communities on the Nakai Plateau represent one of the high-risk groups for these new afflictions? Who will provide on-going health education and/or counseling concerning STIs and HIV/AIDS to potential migrants or seemingly “low risk” groups who remain in the resettlement communities?

The current STI and HIV/AIDS prevention strategies focus on providing information to perceived high-risk groups, such as long-distance truck drivers and women working in the entertainment industry, as well as encouraging these individuals to use condoms. However there may soon be thousands of people at risk to STIs and HIV/AIDS in and around the Nakai district center. Who will provide the information and/or supply the condoms? Who will provide pre- and post-counseling as the situation begins to warrant the routine serological testing of blood for suspected HIV/AIDS cases? Who will provide out-patient, in-patient, or home-care services to people starting to exhibit signs and symptoms indicative of opportunistic infections associated with AIDS? Will treatment strategies eventually include the provision of HAART (highly active anti-retroviral therapy) and long-term follow-up care? Who will take care of HIV/AIDS patients once they become ill, and start returning to their homes from other districts, other provinces, or neighboring countries? It should be noted that the raging HIV/AIDS epidemic in Thailand began in the northern region. It was, to a great extent, sparked by rural migrant laborers descending upon construction camps in and around the provincial center. Rapidly changing socio-economic conditions and behavioral practices at these sites, amongst young men and women, established the foundation upon which the epidemic was fueled. A large percentage of the young men and women working and living at these sites soon became infected with HIV/AIDS. In a very short period of time the infection was subsequently transmitted to new partners or to spouses in their home communities. The entire time frame involving the initial HIV infection, progression to clinical AIDS, and finally to death frequently took considerably less time than that which is designated as the NT2 Project “construction phase”. Complacency should not be a practical or ethical option.

The influx of workers and other migrants, as well as the work schedule for the construction of the resettlement communities, reservoir, power station, and other infra-structural inputs will dramatically increase the number of vehicles, of all types and sizes, on the roads in and around the Nakai Plateau. As such the frequency and severity of vehicular accidents will dramatically increase. Resettlement villagers will comprise an especially vulnerable high-risk group for these types of injuries. In the past most villagers did not live near any roads. Even during journeys to the district center, they probably encountered few, if any, motorized vehicles on the road or in town. Most of those scheduled to be resettled, regardless of age, have no idea about traffic rules and regulations and can easily be severely injured or killed by the increased volume of road traffic that will include vehicles traveling at high speeds. Living closer to the district center, some resettlement villagers may eventually buy bicycles or even motor scooters to transport products they wish to sell in the markets or to commute to jobs in town on a daily basis. Unless a widespread traffic education campaign is enacted,

complemented by rigid enforcement of traffic laws, traffic accidents may become one of the leading causes of morbidity and mortality for certain age-groups living in resettlement communities, as well as for the Nakai Plateau in general. The district hospital will need to be renovated, and appropriate health personnel trained, to take care of trauma, orthopedic, and head injuries.

As the ethnic minority communities, included in the resettlement scheme, begin to have greater contact with the Nakai district center, and the outside world, the incidence of stressed-related and other mental health problems will undoubtedly rise. Many of these potential problems will become more pronounced only after 2010, when all resettlement communities have moved to their new homes. There will nevertheless be a moderate level of anxiety in many families as “generation gaps” develop between older members of households and adolescents and young adults attracted to the manners and “alien” lifestyles found in the district center, and ad hoc settlements near camp sites. A rise in mental health problems may also come about if migrants from the resettlement communities start returning to their home villages after becoming ill with HIV/AIDS. Families of afflicted individuals may become ostracized and excluded from traditional and cultural events. Daily social intercourse amongst neighbors may be disrupted, and some families may suddenly find themselves faced with overwhelming burdens for which they are not prepared. The social development component of the NT2 Project needs to be take pro-active measures, rather than wait until serious problems arise, if they are to address these and other issues, that can potentially create new divisions or social tension within communities as well as within individual households. Health education will not be sufficient. Specific ameliorative mechanisms will have to be put into place to establish creative emotional support networks aimed at dealing with an entirely new set of circumstances. A major challenge will be to enlist the support of traditional leaders and practitioners, rather than merely relying upon the perceived strategies, advice and support of public and private sector agencies.

The Nakai District Center: The Nakai district center is presently a small town consisting of government offices, the district hospital-health center complex, some schools, a Buddhist temple, shops, restaurants, and a market place. The district center contains about 1,500-2,000 residents. By 2010, however, this tiny town, which in many ways resembles a large village, may become a substantial urban center. A great deal will depend upon the size and composition of the new migrants. Will, for example, this primarily consist of small entrepreneurs from provincial and district centers in Khammouane, or neighboring provinces, hoping to earn a decent living by providing basic goods and services needed by the influx of a large labor force? Or will it include a much more diverse group of individuals, including those involved in both small and large-scale entertainment venues? Will local authorities allow these enterprises to expand within the present boundaries of the district center, or will they be encouraged or required to be located away from the municipal center? Will certain types of establishments be discouraged or prohibited by law? Will family members be allowed to accompany the construction workers? Will some or most of them settle in and around the district town, or will they establish ad hoc settlements closer to the work camps? Will workers be discouraged or prohibited from making frequent trips, during their free time, to the district center? Will there be a large influx of women to work in entertainment venues frequented by construction workers, government officials, and others? Will these women gradually come from some of the ethnic communities in Nakai and neighboring districts?

Rapid and unplanned population growth can exert a negative impact on health. Over-crowded living and working conditions are ideal foci for the spread of a wide range of communicable diseases. Lack of safe and clean sources of potable water and the proper disposal of human waste serve as potential “hot spots” for outbreaks, or simply an increased incidence and prevalence, of water-borne diseases. These same living conditions are also conducive for the spread of respiratory illnesses, and a number of serious vector-borne diseases. Public health authorities will need to devote considerably more time and effort to monitor food safety issues in an environment that includes many restaurants, markets, and small food stalls. This will include rodent and insect control as well as garbage disposal. A similar approach has to be undertaken to ensure the safety and quality of medication sold in pharmacies and drug shops.

Unlike the construction workers, those migrating to the Nakai district center will not have to undergo any physical examinations prior to their arrival. As such they may inadvertently introduce new, or perhaps re-introduce communicable diseases previously brought under control. This is especially relevant for malaria, as Nakai district is truly one of the showcases in the National Malaria Control Project. With the distribution of insecticide treated bednets to nearly all households in every community in the district, as well as the training of village health workers and volunteers, to provide early diagnosis and treatment for suspected/confirmed malaria cases, malaria has ceased to be a leading cause of illness and death. The district cannot afford to drop its guard, and continued efforts need to be implemented to ensure that this deadly killer does not return and re-emerge as a major health problem. However some of the new migrants to the district center may originate from geographic areas where malaria was never a health problem. As such they may have no experience with, or appreciation for the importance of, using bed nets and/or ensuring that these items are properly maintained, replaced, and re-impregnated. The *Anopheles* mosquitoes capable of transmitting malaria live in a number of environmental niches not far from the district center. Planned irrigation schemes may to some extent actually increase the number of these mosquito vectors of disease. Hence it is essential that the main components of the malaria control programme in Nakai continue for the immediate future. Who will take the responsibility to educate these newcomers to the district center about the dangers of malaria? Who will ensure that they purchase and properly use insecticide treated bed nets? Who will monitor their use?

Dengue fever (and DHF) is potentially a more serious problem than malaria. This mosquito-borne disease is usually found in urban, and semi-urban, rather than in rural areas. The mosquito vectors usually breed in stagnant water collecting in various receptacles and containers, such as water storage jars, discarded automobile tires, flower pots, etc. Crowded living conditions, with poor environmental sanitation, can lead to explosive epidemics. For those infected with DHF, the onset of serious complications leading to death can take place in a very short period of time. DHF generally affects young children. Are Nakai district hospital staff presently capable of clinically managing DHF cases? Are Nakai district health officials prepared to implement DHF epidemic prevention and control measures, including the use of chemical larvicides?

The rapid growth of the district center is bound to lead to conditions which promote increased casual use of alcoholic beverages and perhaps “recreational drugs” that will alter perceptions and lead to high-risk behavior. The two most dangerous at-risk behaviors will be “driving” and “casual sexual encounters”, while under the influence of alcohol or drugs. The first situation will undoubtedly

lead to an increase in the frequency and severity of vehicular accidents, including death, for drivers, passengers, pedestrians and others on the road. The second situation will lead to a greatly increased risk of contracting STIs and HIV/AIDS as those under the influence of alcohol and drugs often do not take necessary preventive precautions, such as using condoms. As mentioned above, health education campaigns and the promotion of condoms, are insufficient measures to reduce high-risk behavior. A much more comprehensive and pro-active approach needs to be undertaken. This will be discussed in further detail in the sections dealing with “*business as usual*” and “*best practices*”.

Worker Camp Sites: During the 5-year construction phase a series of 12 campsites will be established, for 4,200 workers, at various localities in Nakai and Nhommalat districts. Lao workers will probably comprise the largest contingent in the work force, but professional and skilled workers will also be employed from other countries. With respect to health, a great deal will depend upon whether or not large numbers of camp followers move close to the camp sites. Will this group include spouses and children of the construction workers, or will it primarily be those individuals servicing the various needs of the work force? Either category will create additional demands upon the existing health manpower stationed at the district hospital and district health office. Comprehensive preventive [e.g. immunizations], promotive [e.g. ante-natal care], and curative services will have to be provided for these people. This situation, as mentioned earlier, could indirectly have a negative effect on the health status of ethnic minority communities in the resettlement area or in the NBCA.

Crowded living conditions will, as indicated above, promote the transmission of communicable diseases and serve as potential focal points for the outbreak of explosive epidemics. Unlike the NT2 Project labor force, who are required to undergo physical examinations and perhaps treatment prior to actual employment, camp followers will not follow such procedures. As such it is conceivable that new health problems can be introduced in and around the district center and perhaps onto the Nakai Plateau; depending upon the level of interaction between the various populations. Will it be practical to restrict or prohibit camp followers from establishing ad hoc settlements near camp sites? For those camp sites located in remote areas or on inhospitable terrain, this may be a possibility. But whatever the eventual outcome, it is unrealistic to expect a large work force, receiving regular salary payments, to spend all or much of its free time in project dormitories or canteens. Traveling to and from the district town on a motorcycle, under the influence of alcohol, may in fact be more hazardous than frequenting a small food stall, selling liquor, and then walking back to the work camp dormitory. A key challenge will be how to encourage the work force to relax, when off duty, but at the same time avoid unnecessary excesses that includes high-risk behavior.

The Nhommalat District Center: Although technically located below the Nakai Plateau, it makes more programmatic sense to include the Nhommalat district center in this section as the potential cumulative impacts on health, as well as “*business as usual*” and “*best practices*” strategies, are quite similar to that of the Nakai District Center. The Nhommalat district center is located close to the large work camps near the power station and downstream channel. It is also situated at the confluence of a newly expanded road junction, of Route 8B and Route 12, connecting Thakhek with Vietnam. This will put the district center within two hours traveling time of the Vietnamese border, linking it to cross border trade as well as possible international trafficking activities. In addition the Nhommalat district center is also situated closer to the proposed cement factory scheduled to

open in Mahaxay district. As such Nhommalat town may attract a larger migrant population than the one envisioned for Nakai. Hence the same basic scenarios, concerning crowded living conditions, increased risk of vehicular accidents, the introduction or re-introduction of potentially dangerous vector-borne diseases, and the creation of a serious STI and HIV/AIDS situation propelled by urbanization, migration, and at risk behavioral practices apply here as well.

On a positive note, the MOH has recently indicated that external funding may soon be available to construct a new spacious district hospital just outside the Nhommalat district center, along Route 12. This facility would serve as an inter-district facility, supporting the health care delivery network in both Nakai and Mahaxay districts. This development has obvious health implications for the NT2 Project intervention area.

6.1.2 *Xebangfai Basin and Surrounding Districts*

The potential cumulative impacts on health in the Xebangfai Basin and surrounding districts is expected to be considerably different than that of the Nakai Plateau and the NBCA. Most of the direct impacts will be felt only after the Commercial Operation Date (COD) in 2010, when water is released from the reservoir, passing through the power station, regulating and holding ponds, and downstream channel on its way to the Mekong River. The "Nam Theun 2 Project Xe Bang Fai Strategy Paper" indicates that 89 villages, located along four different sections of the Xebangfai Basin, will be affected by the NT2 Project. This will include 7,096 households containing approximately 40,000 people.

There are several potential impacts of the increased water-flow, in the Xebangfai Basin, which can impact on the health status of local residents. The first, and probably the most important, from a purely health perspective is the increased amount of sediment in water caused by bank erosion in the early stretches of the river. This may reduce the quality of potable water used for drinking, bathing, and other household purposes, causing gastro-intestinal illnesses as well as skin problems. Increased water-flows, especially during the dry season, will undoubtedly improve irrigation potentials and annual rice yields, but they may adversely affect fisheries and gardens in the river and along the riverbanks. This obviously can affect household income and nutritional levels.

The changes in water levels, in and around riparian communities, may influence the prevalence and incidence of rodent and vector-borne diseases such as leptospirosis, malaria, dengue fever, and opisthorchiasis. This concern is most relevant for dengue fever (and DHF), where standing water serves as an excellent breeding ground for the mosquito species capable of transmitting this potentially life-threatening disease. During 2002-2003 large outbreaks of dengue fever occurred in Xebangfai and Nongbok districts. Will the promotion of an additional dry season rice crop, aided by NT2 Project irrigation schemes, cause dengue fever to proliferate and become an endemic health problem to this region? Another potential health issue is the use of pesticides and herbicides in rice-fields and vegetable gardens. Will improved road networks stimulate the production and sale of agricultural products for expanding markets in nearby district and provincial urban centers? What will be the health impacts on producers and consumers? Increased water levels will also probably cause more drowning accidents, especially among young children playing or bathing in the rivers, as well as people simply attempting to cross the river.

The potential direct impacts on the health of the people living in the Xebangfai Basin and surrounding districts are considerably less dramatic than what is predicted for the Nakai Plain and NBCA. There will not be a tremendous influx of workers and other migrants, possible numbering as high as 5,000-10,000 people, inundating the small district towns or surrounding areas in a relatively short time frame. On the other hand, being located closer to the macro and micro-economic developments prophesized by our “crystal ball”, the district centers of Mahaxay, Xebangfai, and Nongbok may experience substantial growth. These districts may witness a massive external exodus of rural adolescents and young adults to the East-West Corridor, the Savannakhet SEZ, nearby Thailand, or even to the work camps and district centers on the Nakai Plateau. Will these migrations be on a temporary or permanent basis? What potential demographic impact will these migration patterns have for “home communities” by the year 2025? Will there in fact be a “next” generation of farmers?

Some of the same scenarios, listed above for the Nakai Plateau and NBCA, are also relevant to the Xebangfai Basin and surrounding districts. By 2010, as the valves on the Nam Theun 2 Reservoir are being opened, a number of cumulative impacts on health may already be in progress. These may include increased exposure to STIs and HIV/AIDS, vehicular accidents, anxiety and other forms of mental illness, and specific communicable diseases caused by new environmental and demographic conditions. By 2010 our crystal ball has predicted that Mahaxay may become a manufacturing center, with perhaps the largest cement factory complex in the nation. Will the dust from this factory become a major environmental health issue locally or for the region? Mahaxay will also be located on the cross-roads of thoroughfares leading from Thailand to Vietnam, as well as linking the central part of Khammouane to the East-West Corridor. The Xebangfai district center, presently situated on Route 13, is already directly linked to Thakhek and the Savannakhet provincial center, will undoubtedly grow in size by 2010. The Nongbok district center, sitting on the banks of the Mekong River just across from Thailand, is connected to Thakhek by a grated unpaved road. But this small district town, and the surrounding area, could easily become a major tourist center if some of the current economic development plans are put into operation. Will local authorities be prepared and capable of dealing with an entirely new series of public health issues caused by economic development, urbanization, and migration?

6.1.3 *Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts*

The direct, as well as cumulative, impacts in the areas referred to as Zone 4 (Nam-Theun Downstream to Theun-Hinboun Headpond), Zone 5 (Theun Hinboun Dam to the Mekong) and Zone 6 (Road 8B “Lak Sao Road” and “Phou Phako Quarry”) are expected to be minimal. This is especially true with respect to health. At the present time there are no established villages or settlements in Zone 4, due to topography and difficult access. The impacts from the reduced flows in the Nam Theun between the reservoir site and the Theun Hinboun Dam will primarily be limited to riparian vegetation, wildlife, and fish. This may mean that the livelihood of a small number of fishermen and hunters, using this area, is affected. Downstream of the Theun-Hinboun Dam (Zone 5) the NT2 Project has no effect on minimum water flows. Flows downstream of the Theun-Hinboun are predominantly dependent upon the operation of the Theun-Hinboun power station. It is expected that the impact on individuals living along the Kading River, to its confluence with the Mekong, will be negligible. Zone 6 presently has few inhabitants. However a large work camp near the quarry at Phou Phako, will be established for construction of the dam site and Road 8B north to its junction with

8A near Lak Sao in Khamkeut district in Bolikhamxay. This work camp, and possible ad hoc camp follower settlements that may spring up here, are already included in the generic issue of *camp-sites* presented in the section dealing with the Nakai Plateau and NBCA. In brief, except for camp-sites and possible camp follower settlements, there will not be any important cumulative health impacts in the Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts by the year 2010.

6.1.4 *Mekong River Basins*

There are not expected to be any immediate or cumulative impacts on health originating in the NT2 Project intervention or adjacent areas that will affect the Mekong River Basins. Even if the increased use of pesticides and herbicides cause local health problems in selected communities or sections of the NT2 Project intervention area, this development should not directly influence the health of humans and other living organisms along the greater Mekong River Basin. Similarly hydrological or macro and micro-economic developments taking place in the Mekong River Basin should exert no cumulative impact on health in the NT2 Project intervention area.

6.1.5 *Neighbouring Areas in Vietnam and Thailand*

The most logical potential cumulative impacts on health, concerning the NT2 Project intervention area and adjacent districts with neighbouring areas in Vietnam and Thailand, primarily concern cross border commerce, tourism, labour migration patterns, and perhaps the trafficking of women and children. The construction, and expansion, of new roads and bridges linking Thailand and Vietnam, will pass through and around the NT2 Project intervention area. Workers, businessmen, tourists, and a large transient mobile population of rural adolescents and young adults may be inter-acting in greater numbers and with increased frequency. Will any Thai and Vietnamese adolescents, young adults, or even women and children become part of the “entertainment industry” near the work camps of the NT2 Project or in the Savannakhet SEZ or East-West Corridor in Khammouane and Savannakhet? Will lowland and ethnic minority Lao adolescents, young adults, or women and children find themselves in the “commercial sex” industry in Thailand and Vietnam? How will the increasing number of Thai and Vietnam tourists and businessmen, stopping off in the district centers in the NT2 Project intervention area and neighboring districts, stimulate the growth of local “entertainment venues”? How will these developments influence the incidence and prevalence of HIV/AIDS & STIs in the Lao PDR and neighbouring countries? What will be the effect of large trucks, zooming along Routes 8A, 8B, 9, and/or 12 at high speeds, between Thailand and Vietnam, on the frequency and severity of vehicular accidents and deaths in local communities? Will the economic opportunities caused by the opening of the East-West Corridor, and new road links between Thailand-Thakhek-Vietnam, encourage families, and/or entire communities, to relocate to sites along roadsides, providing various goods and services to truck drivers, tourists, businessmen, and whoever else passing through their community? How will this unplanned village growth affect the transmission of communicable diseases as well as local health status?

The NT2 Project infra-structural components themselves, that is the construction of the reservoir, power stations, and downstream channel, should not have any direct impact on the health of people living in neighbouring Thailand or Vietnam.

6.2 The 20 Year Scenario

If we were to once again gaze into our crystal ball, what would we see in the Year 2025? An intrinsic problem with our crystal ball, is that although it is capable of making amazingly accurate predictions, it only has a 10-year warranty! It will, however, come as no surprise that the Lao PDR of 2025 does not resemble that of 2004 or even 2010. Momentous physical and spiritual changes may have taken place across the length and breadth of the nation. A majority of the population may live in urban or semi-urban areas, rather than in the rural countryside. An intricate network of roads will crisscross the country from north to south and from east to west. There will more international cross-border checkpoints with Thailand, Vietnam, China, Cambodia, and Myanmar. The tourism sector of the economy will have grown tremendously. The same could be true for manufacturing and industry. Many former visitors and residents, who have not returned to the Lao PDR since 2010 may truthfully claim that they can no longer recognize the place. Some of this group will be markedly impressed by what has taken place in the last 15 years. Others may bemoan the scope and pace of modernization, and its apparent affects on how the Lao treat one another or visitors to their country.

But our main concern is what has taken place in the NT2 Project intervention area, and adjacent districts that underwent macro and micro-economic developments between the years 2010 and 2025?

6.2.1 *Nakai Plateau and Nakai – Nam Theun NBCA*

Nakai district may have changed dramatically. Although the size of the district center may have remained relatively the same, a spectacular real estate and development boom may have occurred along the shores of the Nam Theun 2 Dam. Dozens of hotels, guesthouses, and even houseboats may have been constructed to accommodate the thousands of tourists who annually visit this 70-kilometer long recreation area. The facilities range from low-scale inexpensive guesthouses for “back-packers” to exclusive five-star luxury hotels and spas for the wealthy. Restaurants, bars, gift-shops, and karaoke establishments are sparsely situated along certain sections of the shoreline, but in general zoning laws have kept their numbers in check, and local authorities make sure that illegal activities do not take place in this area. The government, as well as the private sector, has successfully promoted eco-tourism in the NBCA, to the north of the reservoir. Registered companies take small groups of tourists to visit the mountains and forests of the NBCA. Most tours consist of short 1-3 day treks, with overnight stops at specially designated camp-sites. Other tours allow tourists to spend up to a week visiting and observing daily life in selected ethnic minority villages. These tours allow villagers to earn a decent income selling handicrafts and forest products. Residents of the resettlement villages have also benefited from the economic opportunities created in Nakai. Some have prospered producing fresh poultry, livestock, fish, and fruits and vegetables consumed in the district center, and for the hotels and restaurants along the reservoir. Many young people from these communities, as well as from the district town, are employed in the tourist industry along the lakefront. Some ethnic minority villagers, from both the resettlement communities as well as from the NBCA, have been hired to perform traditional dances and rituals for tourists. At the same time some of the smaller remote ethnic minority villages in the NBCA may have merged with neighboring communities, as a result of large-scale migration of younger community members or due to the high numbers AIDS related deaths described below.

Health conditions throughout Nakai district may have dramatically improved. Malaria cases are rare events. Dengue fever occasionally breaks out in epidemic waves every couple of years, but the hospital can deal with all cases, and there have not been any deaths in several years. The improvement in public water supply systems and the use of latrines have dramatically reduced the number of illness caused by water or food-borne illnesses. There has not been a death from diarrhea in more than 5 years!

A major development may be that HIV/AIDS is no longer a serious health problem. The discovery of a clinical “cure” for AIDS, during the period after 2010, has meant that this one-time dreaded plague has been transformed into simply another communicable disease. However approximately 10-15 years ago the HIV/AIDS epidemic swept through many ethnic minority communities, as well as the district center, killing hundreds of individuals in its path and destroying the social and economic fabric of many families. The epidemic killed many young adults, as well as children under the age of five years who were originally infected by their HIV positive mothers during pregnancy or shortly after delivery. For several years it seemed as if there was an AIDS-related funeral every week. Many young children became orphans, and elderly grandparents were often the only relatives left to take care of these youngsters. In addition to the intense emotional stress caused by the epidemic, many families lost their economic base of support when their breadwinner died from AIDS. A recent worrisome trend, however, is that many adolescents and young adults feel that since STIs & AIDS are now curable ailments, there is little incentive to use condoms. Another trend is that poor treatment compliance has resulted in new strains of certain STIs becoming resistant to antibiotics.

The high level of vehicular accidents has not declined on the Nakai Plateau. During the past 10-years it has consistently been the leading cause of morbidity and mortality. Traffic safety campaigns have been ineffective. High levels of alcohol consumption, and an apparent disregard to follow traffic rules, cause many preventable deaths or crippling disabilities each year.

Changing diets, and lifestyles, have also begun to alter the picture of morbidity and mortality. Communicable diseases have become relatively unimportant compared to non-communicable diseases associated with chronic ailments, aging, and new behavioral patterns. Diabetes, circulatory diseases and heart ailments, cancers, psychological problems including depression and suicide, and even obesity are becoming more prominent in Nakai. Many health workers at dispensaries and hospitals, however, have not been re-trained to deal with these “new” health issues. Another important recent development is that private clinics and pharmacies have sprung up throughout the district town as well as along the reservoir. The private sector has now replaced the public sector as the key provider of health care. This is especially true for “tourists” and those working in the hospitality industry.

The Nhommalat district center has also undergone a profound metamorphosis. The town has extended its physical boundaries south to the junction between Route 8B and 12. It has become a major stop-off point for long-distance trucks plying goods between Thailand and Vietnam as well as for international and domestic tourists. Unlike Nakai, however, there are no five-star hotels or fancy guesthouses or houseboats. Instead there are many “entertainment venues” located on the outskirts of town.

The pattern of morbidity and mortality is quite similar to Nakai. Complications or deaths from communicable diseases, such as malaria, diarrhea and respiratory illnesses have become exceeding rare. Dengue fever, however, continues to be a sporadic problem near the district center, although deaths are not common. Although there is a large inter-district hospital, many people nevertheless choose to visit the growing number of private clinics and pharmacies. They feel more confident in the treatment, especially for non-communicable diseases which often require long-term care and follow-up.

The incidence of HIV/AIDS and STIs remains high, due to the large number of transients, especially truck drivers, businessmen, sex workers, and tourists passing through Nhommalat. Like Nakai, resistant strains of certain STIs have been detected recently, and the fact that most males still do not prefer to use condoms means that there is always a low-grade epidemic quivering below the surface.

Nhommalat district continues to encounter a large number of vehicular accidents and deaths due long-distance trucks speeding along the highways. Most injuries and deaths involve pedestrians or drivers of passing vehicles. Vehicular accidents have become the leading cause of morbidity and mortality.

6.2.2 *Xebangfai Basin and Surrounding Districts:*

Some of the health problems that were witnessed during the early years after the completion of the Nam Theun 2 Dam are no longer relevant. This primarily concerned poor water quality due to increased sediment from riverbanks. Within a short period of time the situation returned to normal, either due to a natural reduction in sediment or the mitigation measures implemented by the NT2 Project. This consisted of constructing new wells as sources of safe and clean potable water in affected communities. With the increased use of latrines, water-borne illnesses and intestinal parasitic infestations have practically disappeared. The use of latrines has also interrupted the lifecycle of opisthorchiasis, although older villagers still prefer eating raw or undercooked fish [*laab, goi*]. Malaria is no longer a problem in this region, although dengue fever continues to break out every couple of years. Some outbreaks are quite large, but deaths are exceedingly uncommon.

The district centers of Mahaxay, Xebangfai, and Nongbok, as predicted, have become important urban centers. Mahaxay still holds the distinction of being a major producer of cement, although the discovery of new quarries elsewhere may soon alter this picture. For many years dust pollution, along the road from the quarry to the factory, was a major health concern. During the dry season there was always an increased number of respiratory illnesses especially amongst villagers living close to the roadside. HIV/AIDS and STIs remain important communicable disease problems, but there are now very few deaths associated with AIDS. The leading cause of morbidity and mortality continues to be vehicular accidents. The high volume of large long-distance trucks and other vehicles plying the roads between Mahaxay, Thakhek, the East-West Corridor, and Thailand and Vietnam makes this a very dangerous junction for pedestrians and anybody else on the road.

Xebangfay has grown, but at a much slower pace than Mahaxay and Nongbok. Since it is located less than one-hour away from either Thakhek or Savannakhet, it has never developed into a major commercial or tourist stopover point. It has primarily remained an agricultural production site for domestic markets in the

nearby provincial centers. For many years local farmers substantially increased their use of pesticides and herbicides to stimulate food production. The situation only returned to normal when merchants, in the provincial towns, refused to purchase rice or vegetables grown under these conditions. In the meantime the large number of “unexplained” mortalities in farming communities suggest that pesticides may have been a contributing factor for the high number kidney and liver failures.

HIV/AIDS and STIs continues to remain an important health issue, but many of the patients are actually individuals who work along the East-West Corridor, Savannakhet SEZ, or near Mahaxay. A large percentage of young adults from many farming and fishing communities in Xebangfay district have permanently migrated to these destinations to find full-time employment. During visits home, they frequently seek care at the Xebangfay District Hospital, or at one of the small private clinics or pharmacies in the district town.

Malaria, opisthorchiasis, diarrhea, respiratory ailments, and other communicable diseases are no longer significant health problems. There are, however, regular outbreaks of dengue fever, with an occasional death occurring in a remote community. Vehicular accidents represent the leading cause of morbidity and mortality. The number of accidents, however, is much lower than that seen in Mahaxay or Nongbok. Long-distance trucks and speeding vehicles, at times under the influence of alcohol, cause most accidents.

The general health situation in Nongbok district is similar to that found in Xebangfay district. Serious illness or death, from communicable diseases, have become rare events. STIs & HIV/AIDS remain a problem, but there are a number of private clinics and pharmacies that specialize in syndromic treatment and counseling services. Vehicular accidents are probably the number one cause of death.

6.2.3 *Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts*

This geographic area has basically not been affected by the Nam Theun 2 Project, except for tourists who decide to continue from the reservoir on up to Lak Sao, Khamkeut District (Bolikhamxay), and proceed on over the border into Vietnam. Initially there were a large number of Thai tourists from the northeastern provinces of Sakhorn Nakorn, Nakorn Phanom, and even Udon Thani, of Vietnamese descent, who crossed the Mekong River Bridge into Thakhek and subsequently traveled along this route. This was the shortest and quickest way to their ancestral villages in northern and central Vietnam. The younger generation, however, does not exhibit these same emotional attachments, and simply prefer to visit the reservoir at Nakai or other destinations in the Lao PDR and neighboring Vietnam. This cohort of tourists has at times been the cause, as well as the recipients, of some of the vehicular accidents. They have also played a role in the transmission cycle of STIs and HIV/AIDS.

6.2.4 *Mekong River Basins*

This geographic area has not contributed to any of the cumulative impacts on health in the NT2 Project intervention, nor has it been the direct recipients of health problems originating in Khammouane or adjacent areas.

6.2.5 *Neighbouring Areas in Vietnam and Thailand*

As earlier predicted the new and expanded road and bridge infrastructure connecting Thailand and Vietnam, through the Central Region of the Lao PDR has

by 2025 stimulated the economies in all three countries. The Savannakhet SEZ has attracted direct foreign investments from Thailand, Vietnam and elsewhere. It has also served as a magnet for a large pool of unemployed or under-employed rural and urban lowland and ethnic minority Lao. Tourism has boomed throughout the region, with the Lao PDR becoming an important destination for international travelers interested in eco-tourism. The establishment of a large “service industry” to accommodate tourists, investors, businessmen, and truck drivers has unfortunately also promoted the growth of “entertainment venues” which have from 2010-2025 put large numbers of adolescents and young adults, as well as other age cohorts, at high-risk for STIs and HIV/AIDS. Increased cross-border traffic has, at times, facilitated the trafficking of women and children to certain factories and “entertainment venues” where their mental and physical well-being has been put into jeopardy.

Economic development in this region has propelled the pace of urbanization, and dramatically altered the demographic composition of the rural countryside. Urbanization, migration, and rapid modernization have created new economic opportunities for many individuals, but these forces have also taken a heavy toll on others. Life is lived at a faster pace, which often brings about higher levels of anxiety, depression, and self-destructive behavior. The health picture in all three neighboring countries, in 2025, has dramatically changed from the turn of the 21st century. Non-communicable diseases have evolved as the predominant health issues. Hypertension and heart ailments, along with cancers perhaps caused by exposure to pesticides, dust, and industrial by-products, have become important causes of morbidity and mortality. These chronic health problems are much more difficult to address than communicable diseases, which are of an acute nature. Vehicular, and occupation-related, accidents have emerged as the leading cause of death and illness/disability. But these cumulative impacts on health derive from all macro and micro-economic developments permeating the country and not just the ones put into place by the NT2 Project, the East-West Corridor, the Savannakhet SEZ, the bridge and road construction, and other initiatives.

7 SUMMARY OF “BUSINESS AS USUAL” AND “BEST PRACTICE” SCENARIOS

The preceding sections are based upon a series of predictions concerning specific future development in the area that will influence the type and magnitude of NT2 impacts (added impacts). There is, however, a good possibility that many of these developments never materialize. The Savannakhet SEZ, for example, does not attract direct foreign investment, and never truly evolves into a major regional economic hub promoting cross border trade and commerce between Thailand, the Lao PDR, and Vietnam. The projected cement factory in Mahaxay opens as scheduled, but production levels remain considerably below expectations as Thai cement manufacturers decide not to reduce their exports to the Lao PDR and neighboring countries. The Nakai lake becomes a center for eco-tourism, but it does not attract large-scale investment. Hotels, guesthouses, houseboats, restaurants, and bars do not dot the shoreline. It should be noted that there are quite a number of reservoirs in northern Thailand, surrounded by pristine forests and mountains, that have not attracted any large-scale tourist oriented infrastructure projects to their shores. Some of these sites are extremely popular with both international and domestic tourists, but resorts, hotels, and guesthouses are generally located some distance from the reservoirs themselves. Although a similar situation may evolve at the Nakai lake, there should nevertheless be a marked increase in eco-tourism or simply the number of tour-

ists and travelers visiting or passing through the NT2 Project intervention area by both 2010 and 2025.

In many ways it does not matter if all, or any, of the macro and micro-economic scenarios proceed as envisioned. They represent potential developments and trends that have already been put into motion, especially those propelling an ever-expanding segment of the population to migrate elsewhere for employment opportunities. Thus if jobs are not available, to the extent projected by our ‘crystal ball’, in the East-West Corridor, the Savannakhet SEZ many youth, from both urban and rural areas in the Central Region, will nevertheless migrate to other locations such as Vientiane or Thailand. This exodus may have dramatic effects on local and national population growth rates, as young adults postpone marriage or are separated from their spouses, in home communities, for long periods of time. This can reduce fertility levels and the number of children born each year. Thus relieving potential population pressures on limited or marginal agricultural land. On the other hand migration may transfer higher population growth to urban areas, where the expansion of required social services cannot keep pace with the increasing number of people. These demographic imbalances can interfere with national plans for sustainable economic development.

The preceding sections have not focused on some of the sector developments induced by NT2 activities (induced impacts). Hydrology, for example, is one of the key inputs of the NT2 Project, but the health sector assumes that the calculations promulgated by the engineers and water management experts are reasonable. Thus projected water levels in the dry and rainy season proceed as anticipated. Minor problems focusing on reduced water quality caused by sediment and erosion will be mitigated as outlined in various project documents. Damage to vegetable gardens and fish spawning areas similarly will be addressed, and accordingly household food intake and nutrition levels are not adversely affected. Fluctuating water levels, whether in and along riverbanks, or in irrigated fields can promote ideal living and breeding conditions for rodents, certain invertebrates [e.g. snails] and insects capable of transmitting communicable diseases. But these issues should not present undue problems. Increased pesticide and herbicide use, however, is potentially a more serious health issue in the NT2 Project intervention area.

An important note before proceeding is to point out that many interventions carried out under the title “*business as usual*” are often the same as those prescribed under “*best practices*”. Some suitable examples include a measles immunization provided to a previously unvaccinated young child, or the provision of appropriate contraceptive service to a mother who presently does not wish to have another child. At times the only difference between “*business as usual*” and “*best practices*”, is the manner in which the service is provided to the target population.

7.1 The NT2 Health Action Plan

Chapter 16 (Organizational Framework and Responsibilities) of the NT2 Project Social and Development Plan (Volume 2: Resettlement Action Plan) indicates that the Resettlement Management Unit will contain a Social Services Development Unit staffed by three individuals. This will include a Health Officer, Education Officer, and Ethnic Minority Officer. One of the major roles of the Health Officer will be to manage the implementation of the NT2 Project health component. The project has designated funds for regional, project staff, and resettlers health programs. Although these plans may be substantially modified by the newly de-

signed “Health Action Plan”, below is a summary of the objectives of these three health programs.

The “regional health program” has been allocated \$1,094,000 to mitigate against adverse health effects caused by the influx of an increased construction population, as well as to undertake activities to raise the health standards of the local population. The NT2 Project will coordinate its health care activities with provincial and national health programs. Efforts will focus on:

1. Provision of health education to communities concerning endemic diseases, as well as the implementation of appropriate prevention, control and treatment strategies.
2. Provision of sufficient essential drugs.
3. Training and transfer of appropriate technology to health workers and local practitioners.
4. Support for communicable disease programs.

The “project staff health program” is earmarked to receive \$4,500,000 for a work force of 4,200 construction and project personnel. This will cover the provision of health education for all staff to ensure the maintenance of a healthy work force. The program will include an adequately staffed polyclinic at the main construction camp as well as subsidiary treatment posts at the smaller camps.

The “resettler health program” will receive \$511,460 for the benefit of resettlement community inhabitants. It will provide twice-yearly examinations and special services in all resettled and adjacent communities. The program will follow national and provincial health policies and programs.

The NT2 Project has recently funded a team of external health experts, accompanied MOH officials, to draft a comprehensive “Health Action Plan” [HIA] to be included in the Social Development Plan. This exercise was completed in March 2004. Some of its key features are to up-grade the physical infrastructure at selected district hospitals, up-grade laboratory equipment and the current range of diagnostic services; procure additional medical and diagnostic equipment; and provide training opportunities for health personnel. The “Health Action Plan” is very detailed and professionally covers almost ever imaginable health situation that can potentially arise in the resettlement communities on the Nakai Plateau, at the construction and camp sites, and in other communities in the Xebangfai Basin and adjacent districts. Accordingly the HIA should ensure that “*business as usual*” and/or *best practices*” operates at an optimal level. It is not necessarily appropriate for the CIA document to comment on this plan. Instead the CIA will focus on “*best practices*” dealing with key health issues, that have been discussed in preceding sections. These include:

1. HIV/AIDS & STIs.
2. Vehicular and Other Accidents
3. Mental Health, Depression, Suicide
4. Pesticide Usage
5. Insect-Vector Borne Diseases
6. Water Supply, Environmental Sanitation, and Related Communicable Diseases

7. Other Relevant Health Issues:

7.2 “Business as Usual” and “Best Practices” Scenarios

7.2.1 HIV/AIDS & STIs

This report has intimated that although the present prevalence and incidence of HIV/AIDS in the Lao PDR, including the NT2 Project intervention area, is thought to be low, the situation may dramatically change by 2010. The MOH has recently presented its “Round 4 Proposal” to the “*Global Fund to Fight AIDS, Tuberculosis, and Malaria*”. The estimated budget for the AIDS component is approximately \$7,700,000 over a 5-year period [i.e. 2005-2009]. The proposal plans to scale up existing efforts focusing on targeted behavior change communication for certain high-risk groups, an expanded blood safety program, social marketing of condoms, and improving the capacity of testing centers. New initiatives include the development of a referral mechanism for appropriate services as part of voluntary counseling and testing services and expanding these services into government hospitals. They also include new behavior communication change interventions and strategies for mobile/migrant workers at their site of work. The project hopes to encourage *vulnerable groups* to consistently use condoms, and make better use of available STI and voluntary counseling and testing services. Individuals subsequently needing specific services will be referred to facilities and organizations providing appropriate care through new referral mechanisms. The blood safety program is envisioned to protect those needing blood transfusions in 11 provinces in the Lao PDR.

One of the problems with “*business as usual*” is that program designers and service providers, called upon to implement the plan, frequently do not appreciate all of the dynamic and inter-related factors that can contribute to an HIV/AIDS epidemic. Most health workers in the Lao PDR, for example, have never seen an AIDS patient, in the early stages of illness, nor have they witnessed full-blown AIDS or an AIDS related death. Since they have not encountered individuals and families affected by AIDS, they still have not learned that AIDS is not necessarily restricted to selected groups of people participating in high-risk behavior. Nor do they fully understand that so-called *vulnerable groups* include *all sexually active people* as well as those *soon to become sexually active*. This covers an extremely large population. The degree of risk depends upon certain behavioral practices, but in reality *sexually activity* is a basic and natural phenomenon for all species, including human beings.

The NT2 Project, nor local government officials, can not afford to take a wait-and-see approach before deciding to implement appropriate measures to prevent and manage an HIV/AIDS & STIs situation that can easily spiral out of control. The NT2 Project should complement all efforts of the National AIDS Program, as well as spearhead additional interventions by providing adequate levels of funding for prevention, counseling, treatment, and outreach home-care services for its work force and people living in the NT2 Project intervention area. This should include, but not be restricted to the following activities:

Regular Awareness Raising - Information Dissemination Campaigns in all resettlement communities concerning the nature of HIV/AIDS and STIs, as well as explaining what actions can be taken to prevent and treat these illnesses. Separate venues can be established for males, females, as well as adolescents and young adults in order to facilitate inter-active discussions, questions, and op-

portunities to express fears and concerns. Although initial efforts should include health professionals, representatives of mass organizations [e.g. LYU and LWU], and NT2 Project extension workers, a mechanism should be devised to train a network of selected villagers to serve as peer educators for their specific cohort group. These peer educators can act as first-stop “information-counseling points” before recommending further referral for more appropriate services. Similar *awareness-information dissemination campaigns* need to be implemented at construction camp dormitories, camp follower sites, in district centers, at secondary schools, and at places where perceived “higher-risk” groups gather [e.g. truck stops, bars, etc.]. A system of well-trained peer educators is an essential component of this initiative. Adolescents and young unmarried adults rarely feel comfortable discussing sexuality with government health workers who may not approve of their behavior.

De-stigmatizing Campaigns in all resettlement villages, in district towns, schools, construction camps, places where perceived “higher-risk” groups congregate, and other appropriate venues. One of the tragedies of HIV/AIDS in the era when there was no treatment, but which still continues today, concerns the fact that AIDS patients and their family members have been unnecessarily, and at times cruelly, ostracized and abandoned by their communities. This should not be allowed to continue since HIV/AIDS, and STIs, are merely communicable diseases, which do not put the general population, community members, or people in one’s family at risk unless there is a certain level of specific intimacy involved. De-stigmatizing HIV/AIDS so that it is seen as one of many illnesses that can be transmitted to others under certain circumstances, will encourage people to seek information, counseling, and care, in an appropriate and timely manner. This development, by itself, can dramatically reduce the risk of further transmission. In order for such a strategy to succeed, one has to enlist the support of influential people. Although this may include government officials, it also has to include well-respected natural leaders such as monks, village headmen, traditional practitioners, and others who people turn to in times of trouble. De-stigmatizing messages can be inserted as part of regular sermons at Buddhist temples or other religious ceremonies, or at village gatherings. Before a potential HIV/AIDS, and/or STI, epidemic emerges people need to understand that they should not be afraid of this illness. If proper precautions are taken, nobody else need be infected. And if infection develops, there are ways to prevent further transmission, as well as to treat some or all of the signs and symptoms associated with the illness.

Designing Effective HIV/AIDS [& STI] Counseling, Treatment, and Outreach Care Strategies

At the present time there are not any blood testing, counseling, or treatment services for HIV/AIDS at district hospitals. One cannot develop an effective prevention and control program unless it contains these essential components. To do so trainees have to be selected carefully, and sent to sites and/or facilities where they can obtain hands-on competency based skills, as well as theoretical information to expand their understanding of this illness. Since there are very few sites in the Lao PDR that handle large HIV/AIDS patient loads, or implement village-level outreach care services, the NT2 Project should consider other alternative options. In consultation with local authorities and the National Committee for the Control of AIDS, it may wish to explore providing support for short-term study tours, of varying length, to observe dynamic and effective HIV/AIDS counseling, treatment, and outreach care initiatives at appropriate health facilities in Thailand.

The Sanpathong district hospital in Chiang mai/Thailand, is a facility that manages the clinical treatment of hundreds of HIV/AIDS patients. Its out-patient and in-patient wards continually have a flow of AIDS patients suffering from a wide range of opportunistic infections who are clinically managed according to symptoms and/or with HAART [highly active anti- retroviral therapy]. It offers a full range of diagnostic tests, including HIV serological confirmation as well as CD4 and viral-load counts to better manage treatment schedules. The facility has an “user friendly” counseling service for anybody interested in learning about HIV/AIDS or for patients and family members suffering from this illness. It also operates an outreach home-care program in close coordination with sub-district level health centers and NGOs. It is an ideal setting for health professionals, mass organization representatives, and peer educators to learn how to establish and operate a comprehensive HIV/AIDS prevention, counseling, and clinical treatment and management program. The district hospital has also been instrumental in designing community based initiatives that have de-stigmatized HIV/AIDS.

The PATH Foundation Philippines, Inc., a local NGO, has worked with the MOH and the private sector to created the largest STI syndromic treatment and management program in the country. It has trained, and continues to re-train, a network of hundreds of private pharmacies in urban and rural areas that provide information, counseling, and syndromic treatment to STI patients and contacts. Similar study-tours can be arranged to observe how this initiative was established, as well as to learn how it has been able to remain entirely self-sustainable.

Establishing “User Friendly HIV/AIDS & STI Counseling and Treatment Facilities:

In addition to properly training health staff and others, to provide high quality counseling and treatment services, facilities need to be located in appropriate settings. Many people, especially adolescents, unmarried adults, and others [e.g. truck drivers, construction workers, females engaged in the “entertainment sector”], often avoid visiting government hospitals. It is either inconvenient or too public a venue to be seen seeking these types of services. As such other more “user friendly” sites need to be identified and supported to provide HIV/AIDS & STI counseling and treatment services. These facilities can also serve as convenient outlets for condoms, as well as other contraceptives [e.g. oral pills and emergency contraceptive pill-packets] to prevent unwanted pregnancies and reduce the risk of abortions, in rural or urban areas. The LYU and LWU should be invited to play an important role in the design and operation of this project component. The counselors should be drawn from target cohort population(s) as well as include professional clinicians. This can include people from both the public and private sector. The construction camps are an ideal setting for some of these “user friendly” facilities, but other venues need to be incorporated into the scheme. It can include Youth Clubs in schools, during the evening, or for similar clubs established at rural health facilities in the resettlement village area. It should include places where young people congregate to relax and meet on a social basis. The number and type of sites and settings can vary according to locale. Peer educators and professional health workers can receive certain incentive payments for their participation. A key function of these “user friendly” counseling and treatment centers, should be to serve as focal points to help adolescents and young adults acquire basic “life skills” to more successfully deal with new circumstances and situations that can easily emerge in a rapidly changing socio-economic environment. This can include teaching young women not only

about the risk of HIV/AIDS and STIs, but also how to negotiate “safe sexual practices”, such as convincing permanent and casual partners to consistently use condoms. “Life skills” also include instructing young adults how to balance a weekly or monthly budget to ensure that they do not easily go into debt, and come under undue stress and worry that can lead to alcohol and drug abuse, or other self-destructive behavior.

Establishing Outreach Home-Care for People and Families Living With AIDS

Many HIV/AIDS patients, and their families, will not be able to visit government health facilities or “user friendly” counseling and treatment sites, for a variety of reasons. Some of these people may feel embarrassed and not wish others to know of their HIV/AIDS status. Others will simply be too ill to travel outside their home, or unaware of where to go for appropriate care. The NT2 Project should try to establish a “confidential data-base” of HIV/AIDS affected families to help provide social and medical services to its work force as well as to others living in the NT2 Project intervention area. If the disease is de-stigmatized before it turns into a major epidemic, there will be a greater chance that it will be looked upon as simply another communicable illness and affected people and families will not have to conceal their identity. Home health care visits, as part of routine outreach mobile clinics, to resettlement villages, communities in the NBCA, or in and around the district centers, will not attract undue attention. They will make it possible for AIDS patients to receive proper care as well as to monitor medication schedules for serious long-term opportunistic infections [e.g. Tuberculosis] than can possibly be transmitted to other family members.

7.2.2 *Vehicular and Other Accidents*

The frequency and severity of accidents will greatly increase during the “construction and community resettlement phase” of the NT2 Project. This report has predicted that within a relatively short period of time, accidents may become the leading cause of morbidity and mortality in the Lao PDR. This development should not come as any surprise because this phenomenon is being witnessed throughout much of the world, especially in southeast Asia. Although there are many types of accidents, vehicular accidents will become the most serious cause of injury, disability, and death. One relevant question is whether vehicular accidents can be prevented in developing countries? In urban, as well as many rural settings, the large-scale use of motorized vehicles seems to have materialized, as if by magic, almost instantaneously. People who have never sat as passengers are now plying along the thoroughfares, in various acrobatic positions and at velocities usually associated with home-made rockets. There does not seem to be any formal driver’s education requirements necessary to obtain a driver’s license, and traffic rules and regulations are frequently not enforced by local authorities. In such an environment, the following scenario is hoped to be a reasonable approach that can go beyond “*business as usual*” and evolve into “*best practices*” strategies. It can include, but not be limited to, the following components:

Establishing a District Road Safety Awareness Plan

The NT2 Project should work closely with local government authorities, mass organizations, and village and traditional leaders to increase awareness about the dangers of vehicular accidents, to ensure that this issue is given a much higher profile and priority than currently exists. These leaders need to be informed, and appreciate the fact, that vehicular accidents may soon kill, disable, and injure

more people in their communities than all communicable diseases combined. District authorities need to design and implement practical strategies that can impact on the issue. Passing rules and regulations that are not enforced, or allowing anybody regardless of age, or a formal demonstration that they can operate a vehicle responsibly, to be driving on the roads will simply perpetuate the current situation. The plan should, like the one suggested for HIV/AIDS awareness, be taken to the village-level as well as brought into schools, temples, work sites, and other venues where young people congregate. It should avoid unnecessary rhetoric and provide opportunities for drivers to gain an understanding of road safety as well as acquire safe driving habits and skills.

Establishing A Road Safety Enforcement Unit

All individuals, whether police or other government officials, responsible for road safety enforcement should be enrolled in special courses to review existing traffic rules and regulations. They should be given explicit instructions on how to enforce rules and regulations when encountering major categories of infractions (e.g. speeding, driving under the influence of alcohol, driving without a license, driving with an expired license, being under the legal to operate a vehicle, etc.). Village leaders should also be enrolled in a modified road safety enforcement program. This would allow them to warn or fine villagers who are a hazard to the safety of their community while driving; whether it is for speeding, driving while under the influence of alcohol, or allowing children below the legal driving age to operate a motorized vehicle. Fines should not be high or arbitrary. Communities should also verbally indicate beforehand whether or not that they wish to participate in such a road safety scheme before enrolling village leaders into the program.

Constructing Traffic Lights in District Towns and at all Major Intersections

One of the main reasons that vehicles travel at high speeds, through populated as well as unpopulated zones, is that there are very few traffic lights on roads or at major intersections. As such there is no need for drivers to adjust their speed limit, even when passing through populated areas or at major intersections where there may be on-coming traffic. Traffic lights are more effective than traffic signs. Although many district centers are quite small, there should be a national or local [as in the case of the NT2 Project] policy to construct at least three traffic lights at these sites. This can consist of one traffic light at either end of the town, before entering and leaving the district center. Another traffic light can be erected in the middle of town or at any major intersection in the district center. This policy will force all vehicles, but especially long-distance trucks traveling at high speeds, to slow down and/or stop before passing through the district center. Similarly traffic lights should be constructed at all major junctions and intersections, in the rural countryside, to avoid serious head-on collisions. In many parts of the country one can travel for more than one hundred kilometers, at a stretch, without encountering a traffic light. Functional traffic lights unconsciously teach drivers to reduce speed while passing through populated areas that may have pedestrians or bicycles on the road. Prompt law enforcement, and the payment of stiff fines, for infractions, may gradually encourage people to drive more carefully.

Establishing Formal Drivers Education Courses in all Districts

In many countries drivers' education is a required part of the national or provincial educational curriculum. Some programs simply focus on traffic rules and regulations, in preparing interested students to take a formal written examination and a

practical driver's demonstration test. Special "driving schools" instruct students to properly operate a vehicle. Other programs focus on both components; teaching students the basic "rules of the road" as well as how to operate a vehicle to prepare for formal examinations. The NT2 Project should support formal drivers' education courses at the construction sites, for project and government personnel in the district town, as well as for villagers in the resettlement communities and for students attending the secondary school in the district town. Course material should make use of videos, as well as more inter-active methodologies such as "role playing" and "case studies" to illustrate important points as well as make "potential drivers" understand that their behavior on the road can have serious consequences for themselves and others. Once again it would be a good idea to enroll the support of monks and other religious leaders to emphasize the ethical responsibilities of operating a vehicle, since it may lead to the death or disability of an innocent bystander.

Establishing a Financial Incentive Policy to Encourage Safe Driving Habits for NT2 Project Personnel

The NT2 Project should consider establishing a formal policy that offers financial incentives for its drivers, construction workers, and other employees who have a safe driving performance record. This issue may be more relevant to project personnel employed as drivers, but it can include construction workers and other staff as well. The rationale is that NT2 Project employees should receive annual bonuses for safe driving records, as well as fines or dismissals [i.e. in the case of those hired as drivers] for minor and/or serious traffic violations and infractions. Financial incentives, and disincentives, are a very effective means of encouraging project employees to drive carefully and avoid unnecessary risks. Project employees, especially those hired as drivers, need to know that they will be personally held accountable for hazardous driving that endangers the life of others. Safe driving can include the consistent use of safety belts, helmets, having rear-and-side-view mirrors on motorcycles and larger vehicles, etc.

Establishing Village-Level First Aid and Emergency Care for Accident Victims

In addition to vehicular accidents, villagers may also face an increasing array of other types of injuries that could result in disability and death. For those living downstream along the Xebangfai Basin, rising water levels created by the release of water from the reservoir, power station, and regulating and holding ponds can potentially increase the number of drowning accidents. Village level awareness campaigns need to be introduced by the project or by other relevant government agencies and mass organizations. The LWU, and village-schools, are an ideal mechanism to instruct mothers and young children about the need to follow safety precautions while bathing, playing, collecting water, or washing clothes in and alongside the river. Occupational accidents in the fields and injuries around the house should be similarly addressed by a NT2 Project sponsored accident awareness and "first aid and emergency care" training program for health dispensary workers and VHVs. At the present time "first aid and emergency care" is not a basic component of pre-service and in-service training courses for village level health workers and volunteers. The potential increase in drowning related accidents, especially amongst young children and women, living in riparian communities should be a high priority for the NT2 project. Medical staff, at the project polyclinic at the main campsite, can assist district hospital personnel design an appropriate in-service curriculum that enables village health workers and volunteers to obtain specific competency-

based skills. This should include artificial resuscitation for drowning victims, as well as the cleaning, suturing, and dressing of minor wounds sustained at home or at work. The course should also teach health workers and volunteers how to prepare injury victims who need to be referred and transported to a district or provincial hospital, so that the journey does not exacerbate their condition or lead to permanent disabilities. Village level health workers and volunteers should also be trained to provide emergency care for pesticide poisoning accidents as well as for eye trauma caused by pesticide inflammation.

Up-grading District Hospital to Treat Accident Victims

The “Health Action Plan” indicates that the project will train health staff at the Nakai and Nhommalat district hospitals to treat and stabilize major injuries and illnesses [basic orthopedic services, eye trauma services, road and construction accidents]. This sounds fine on paper, but it may not take into consideration the educational and medical background and experience of existing health personnel. As mentioned earlier, in this report, each of these two facilities presently have only one physician. They, and other staff, have never been trained to perform any surgical procedures. Assuming that the NT2 Project could organize this and other technical training programs, what assurances are there that these individuals would remain in remote districts if there were vacancies at the provincial health hospital or health office.

A “*best practice*” strategy may be for the NT2 Project to establish a special post-graduate or in-service training “scholarship fund” to attract clinicians, surgeons, obstetricians, laboratory technicians, vector-borne disease and public health specialists to commit themselves to at least 5 years of public service in Nakai and/or Nhommalat districts. Depending upon the specialty, training could consist of ongoing post-graduate, or special courses, offered at Mahosot, Friendship, and Setthathirat Hospitals in Vientiane. The course of study could also include degree and/or short-term study programs at internationally recognized institutes from countries in the Asia region. Fieldwork could take place in the NT2 Project intervention area. This proposal should attract more health professionals to remote geographic areas, as well as establish a core group of specialists who could subsequently, over a period of time, conduct continual in-service training for co-workers at district and village level health facilities.

More specifically the NT2 Project may wish to adopt a similar approach that was undertaken by the Consortium in the Lao PDR, an international NGO, which has assisted the MOH implement the “War Victims Assistance Project” (WVAP). The WVAP has dramatically improved the capacity of provincial and district hospitals in Xieng Khouang, and Houa Phan, to provide emergency, medical, and surgical care to UXO [Unexploded Ordnance] accident victims. Working closely with surgeons and nurses, at the Friendship and Mahasot Hospitals in Vientiane, a full range of clinical and surgical training courses have been designed and implemented for selected staff at the provincial hospital level, as well as for all professional staff deployed to the district hospital level. The training program is based upon a team-teaching and on-site visit supervisory approach, which cascades down from the national to provincial to district level. The WVAP, in a relatively short period of time, has dramatically improved the capacity of urban and rural health facilities to deal with life-threatening emergencies. Professional staff have been trained to work as a team at Intensive Care Units, Emergency Rooms, and Operating Theaters. They can deal with most trauma issues, and perform selected orthopedic surgical procedures. Although the WVAP is designed to address the needs of UXO victims, the major beneficiaries are in fact the large

number of people injured in vehicular accidents, as well as other patients needing modest-mid level surgery.

7.2.3 *Mental Health, Depression, Suicide*

The NT2 Project will put into motion certain forces that may directly impact upon the mental health of people living in the project intervention area. At a minimum the NT2 Project will relocate selected ethnic minority communities presently living on the proposed reservoir site. Although this resettlement process will, for most communities, consist of a physical move of < 5 kms from their current homes, it may set off a chain-reaction that upsets the normal course of daily life for many families and communities as a whole. The “Ethnic Minority Development Plan” and “Resettlement Action Plan” outline specific measures to take to minimize possible adverse effects of this relocation, as well as ensure that the lives of the affected population are improved. This report, however, has indicated that within the 5-year construction and resettlement phase, other related developments on the Nakai Plateau or in adjacent geographic areas, may cause an entirely new realm of disruptions to communal life, or cause problems within families.

The large influx of construction workers and other migrants, to the district center, will undoubtedly promote changes in daily lifestyle and ways of thinking. Resettlement communities may soon turn away from subsistence farming and be drawn into the market economy. This can include the production of food and other products for sale in the district markets, or by serving as a source of labor for various businesses and venues providing goods and services to construction workers and others in the district. The latter category will probably include adolescents and young adults, who as indicated elsewhere in this report, may decide to travel further away from their homes in search of employment. While this development may promote the inclusion and integration of remote ethnic minority communities into the socio-economic fabric of Lao national society, it can also result in internal conflicts between family members, especially those of different generations. Large-scale migration, both into and out from, Nakai and to a lesser extent other neighboring districts, will erode traditional values and practices, as well as perhaps lead to the disappearance or daily usage of ethnic minority languages within the span of one generation.

The potential effect of an HIV/AIDS epidemic in ethnic minority communities will be devastating for family members who have to care for patients, as well as take care of orphans and/or replace the household’s primary source of income. Constant daily anxieties may develop, in certain households, as migrating family members fail to send home any news of their living/working conditions, or anticipated remittances to support the family unit. For those migrating away from homes, a certain percentage will undoubtedly find themselves in situations where they are physically or mentally abused, or where they feel isolated and disoriented in an alien and perhaps hostile environment. All of the above scenarios will probably lead to an increase in the prevalence and incidence of mental illness. This can include depression, alcohol and substance abuse, violence, and perhaps suicide.

Dealing with the increased amounts of daily stress, associated with modernization, is not a simple task whether one lives in a developed or developing country. It is considerably easier to treat acute illnesses, than chronic conditions for which there may not be a specific cure or ameliorative therapy. A major constraint in the Lao PDR is that the health care delivery system is currently inadequately prepared to deal with mental health issues and problems. Hospitals are not

staffed with psychologists, social workers, counselors, or others trained to handle actual or potential emotional problems. A similar situation exists among other government line agencies and mass organizations. Accordingly some of the proposed “*best practices*” strategies may in fact be impractical to implement.

Establishing Public Awareness Raising Campaigns Concerning Mental Health

Local authorities, members of mass organizations, and community members need to be re-oriented to understand that an entirely new set of circumstances will shortly be underway, as remote districts in Khammouane are gradually brought into national economic development schemes. These groups need to understand and appreciate that mental health problems, just as was the case with vehicular accidents, will become a major cause of illness and perhaps even death in the near future. Members of the LWU and LYU, as well as teachers and community leaders, need to take a major role in being trained and prepared to handle some of these issues. Special courses on mental health preparedness and problem resolution interventions should be conducted on a regular basis.

Establishing Job Placement Agencies to Monitor Domestic and Overseas Migration as well as to Prevent the Trafficking of Women and Children

The NT2 Project should work closely with local authorities, mass organizations, and businesses to establish a local job placement agency. This agency would assist ethnic minority community members, and others, to find suitable employment in Nakai, Nhommalat, and neighboring districts. The agency could ensure that workers are paid as agreed upon in their contract, and that working and living conditions are adequate. The agency would try to keep track of local people who have migrated to other geographic areas of the country [e.g. the East-West Corridor] or to neighboring countries to ensure that women and children are not lured under false pretenses to become part of trafficking networks. This will not be an easy task, but if potential employers see that local government authorities are concerned about their citizens and are willing to keep track of their whereabouts, it may deter unscrupulous agents from entering the NT2 Project intervention area.

Establishing Emergency Mental Health Hotline Clubs

In many urban areas, “emergency mental health hotlines” have been established. These networks employ professional counselors and operate on a 24-hour a day basis to assist “callers” with problems or difficult situations, or to talk with people who may even be contemplating suicide. Although this strategy may be impractical for the Nakai Plateau and other areas of the NT2 Project intervention area, “emergency mental health hotline clubs” for youth, parents, and other at-risk cohort groups can be established in ethnic minority villages, the district center, or at other appropriate venues. A key component of this strategy is to train local people [e.g. teachers, monks, traditional practitioners, members of the LWU/LYU, adolescents/young adults, construction workers, “bar girls”, etc.] to become effective “first-point” counselors for their peers or a larger population. Many people, experiencing an emotional issue, simply require an opportunity to discuss their problem, before feeling better. Others will need professional medical/psychological assistance. If local authorities do not have the proper experience to establish such clubs, or conduct appropriate training, the NT2 Project may wish to invite an experienced NGO, or individual, to help with this assignment on a part-time or full-time basis.

Promoting the Preservation of Tradition Values and Customs

Those who promote the benefits of globalization frequently suggest that these socio-economic changes offer new and unlimited challenges and opportunities for present and future generations. They sometimes ignore the fact that our “global village” may in fact contain less diversity and fewer viable life-styles today than it did 20-50 years ago. The NT2 Project should assist local communities to preserve their traditions through a variety of mechanisms. This can include the promotion of tradition festivals, or the modification of curriculum in local schools which encourages traditional practitioners, religious leaders, farmers, and housewives to enter the classrooms as guest speakers. This approach will help students understand the rich cultural heritage that their parents and ancestors have preserved up until now, and have helped pass down from generation to generation. Some of these “special lectures or demonstrations” can be included as part of the regular coursework on history, biology, health, language arts, etc. Some of these topics can perhaps also be introduced as part of special mini-courses held during annual school vacation periods. In addition to enriching the educational experiences of students, this strategy can help the younger generation appreciate their various diverse cultural backgrounds. It can help students understand that in life one can have separate identities or facets to their personality, and that it is not necessary to be limited a single option.

Pesticide Usage

Although the agricultural extension component of the project will emphasize “Integrated Pest Management” and the avoidance of chemical pesticides and herbicides, unforeseen circumstances may eventually encourage farmers to abandon this approach. Irrigation, during the dry season, will promote the cultivation of a second rice crop and/or additional cash crops; and local, national, or regional market forces may promote the use of pesticides and herbicides to increase yields, exports, and incomes. The use of chemical pesticides and herbicides will endanger the health, and perhaps the lives of many people. Pesticides can be absorbed by the skin, inhaled through the lungs, and consumed through water and food contaminated by these products. Chemical pesticides and herbicides can also enter waterways, from the rice-fields, and gradually endanger the entire ecological system. Not all scientists and physicians agree on the level of pesticide exposure needed before an individual becomes acutely or chronically ill. However chemical pesticide and herbicide usage has been indirectly implicated as a major causative factor in the growing number of cancers, and liver and kidney problems, in rural farming communities throughout southeast Asia. The storage of toxic pesticides and herbicides, in and around homes in rural communities, may also lead to unintentional poisoning accidents or attempted suicides. This has been the experience in neighboring countries.

The NT2 Project should assist local authorities to take pre-emptive measures to ensure that this problem can be avoided, or minimized to the extent possible. Some of the “*best practices*” strategies could include the following:

Promoting Pesticide/Herbicide Awareness Campaigns

Many farmers in the NT2 project intervention, especially on the Nakai Plateau, have limited experience with the use of chemical pesticides and herbicides. It is important that they, as well as local authorities, understand both the short-term and long-term implications of extensive chemical pesticide use, on the environment, and on the health of communities, households, and individuals. Local

merchants, restaurant owners, and others buying agricultural products from farmers similarly need to be appraised of the dangers associated with chemical pesticide usage. Local authorities should encourage all potential consumers and traders to only purchase agricultural products that have not used chemical pesticides. If consumers understand the importance of following such a policy, it will act as an incentive for farmers to follow integrated pest management approaches.

Instructing Farmers and Others How to Properly Use and Store Chemical Pesticides and Related Equipment

Although the goal should be for the establishment of a “chemical pesticide free zone”, this may not be practical under all circumstances. There may be times, and conditions, under which chemical pesticides need to be used. As such the NT2 Project should assist local authorities prepare IEC and other training materials to demonstrate how to properly prepare, use, and store chemical pesticides and herbicides. This can be accomplished through the use of videos, role-playing demonstrations, or other appropriate methodologies. Agricultural extension agents, the LWU, and other government agencies need to participate in this initiative for success. Farmers need to know what type of protective clothing they should wear when preparing and using pesticides. They also need to know how to properly clean utensils and containers used to apply pesticides; and what measures to ensure that these items do not contaminate the environment. Both farmers and mothers need to know how to store pesticides so that they are out of the reach of young children and do not pose any danger to household members. It would also be useful for local schools to include topics concerning the dangers of chemical pesticide usage, and safety measures to take for the prevention of pesticide poisoning accidents as part of biology and health lessons.

Establishing Emergency Treatment Programs for Pesticide Poisoning Accidents

The NT2 Project should support training courses for health personnel at district hospitals and health dispensaries, as well as for village health volunteers, to provide prompt emergency first aid care for accidental or intentional [e.g. attempted suicides] pesticide related accidents. Although ingestion will be the most common medium of pesticide accidents, first aid courses need to cover emergency eye and skin trauma care resulting from exposure to chemical pesticides. In rural areas of Thailand, pesticide-attempted suicide are quite common, especially among adolescents and young adults who cannot deal with minor disappointments in life and who do not realize the seriousness of their actions. This development has already been anecdotally mentioned as a cause of increasing suicides in Nongbok district.

7.2.4 Insect-Vector Borne Diseases

Malaria and dengue fever will continue to be significant health problems requiring specific attention in the NT2 Project intervention area during the construction and resettlement phase. The “Health Action Plan” outlines a number of measures to support national, provincial, and district initiatives to control these two important insect-vector borne diseases. Although the prevalence and incidence of malaria has dramatically declined in Khammouane, as well as throughout the Lao PDR, sustained long-term interventions are required for the foreseen future. As mentioned earlier, the MOH has just presented its “Round 4 Proposal” to the “*Global*

Fund to Fight AIDS, Tuberculosis, and Malaria". The estimated budget for the Malaria component is approximately \$14,500,000 over a 5-year period [i.e. 2005-2009]. The key service delivery areas under the National Malaria Control Programme are vector control with the use of insecticide-treated bed nets, rapid diagnosis and treatment of falciparum malaria cases, and the provision of subsidized bed nets and anti-malarial drugs to poor and vulnerable populations in hard-to-reach areas.

The MOH expects to cover 100% of the 3.6 million people currently living in endemic malaria areas, throughout the country, through the use of either re-treatable nets and/or long-lasting nets [LLN]. Treatment with artemisinin-based combination therapy (ACT) will be instituted to address the increased resistance to chloroquine and sulfadoxine-pyrimethamine. The MOH hopes to reduce the malaria morbidity rate from 6.6 to 1.3/1,000 population, and malaria deaths from 187 to 37 by the year 2009. New drug treatment policies and the use of LLN are expected to reduce the workload and expenses incurred during annual campaigns and re-treatment of bed nets. These measures should hopefully resolve most of the logistical, technical, and operational problems encountered in the first phase of the Global Fund Grant.

Dengue fever [and DHF] may potentially become a more serious health problem in the NT2 Project intervention area. In 2002-2003 several districts in the lower Xebangfai Basin [e.g. Nongbok and Xebangfai districts] experienced explosive outbreaks of dengue fever. There are some major differences between dengue and malaria. Dengue is more prevalent in urban than rural communities, but it can rapidly spread to peri-urban and rural areas as well, often with a high mortality. Unlike malaria there is no specific chemotherapy for dengue, and clinicians must rely on supportive care and proper management of intravenous fluids to prevent the patient from going into shock. *Aedes aegypti* and other related species of the genus are the vectors associated with the transmission of dengue fever. These mosquitoes breed in small collections of water, frequently in and around houses. They tend to be active during the daytime, and hence sleeping under insecticide treated bed nets does not offer any protection. At the community level early diagnosis, rapid referral to the next level, and informing local authorities of an impending outbreak are important actions to be taken. At the district hospital level case management of DHF is the most important intervention, but it may be necessary to rapidly evacuate the patient to a provincial or regional hospital. In many ways dengue is more difficult to control as the mosquito vectors live in close proximity to susceptible human hosts. In the case of malaria, mosquito-breeding sites may be situated many kilometers from the home of susceptible human hosts.

With the influx of more than 4,000 construction workers and perhaps several thousand additional migrants, to the NT2 Project intervention, there will be an increase in optimal breeding conditions for *Aedes aegypti* mosquitoes. Areas where people congregate during the day such as work sites, living quarters, schools, markets, and hospitals should be targeted for control activities. Increased spontaneous settlements, with inadequate water supply (and the need for domestic water containers) and the increased use of rain-filled tires and other containers will lead to increased *Aedes aegypti* populations. Crowded living conditions and increased population movements will exacerbate transmission. These same cohorts may also serve as a focal point for new malaria outbreaks unless they are included in prevention, control, and treatment strategies of the National Malaria Control Programme.

Some “*best practices*” strategies can include the following:

IEC Information and Awareness Raising Campaigns

Local government officials, mass organizations, rural communities, new migrants, and people living in the district center need to understand that malaria has not been eradicated, and that the measures used to control and treat malaria have no effect on the transmission of dengue fever.

Establishing Weekly “Community Mobilization Clean-Up Campaign” Activities

It is important to mobilize the various at-risk populations to understand the importance of emptying any containers [e.g. water jugs, flower pots, discarded tires, etc.] lying in and around the house which can serve as breeding sites for *Aedes aegypti* mosquitoes. These containers must be emptied and scrubbed [both on top and bottom sides] to remove mosquito eggs. Essential water containers, such as domestic water storage jars, and other containers that cannot be easily removed from the environment, should be treated with appropriate insecticides. It is best to organize a team consisting of health professionals, members of mass organizations, housewives, workers, students, etc. who can systematically go around the village, district town, camp sites, work areas, etc. to ensure that all potential breeding sites have been emptied and/or treated with insecticides. This activity has to continue throughout the entire breeding/transmission season. In many communities, the mobilization clean-up campaign takes place on every Saturday.

Conducting Emergency Spraying Operations

In the event of a dengue fever epidemic, it may be necessary to conduct emergency spraying operations. The NT2 Project may wish to support these activities if resources from the provincial health office are inadequate for the purpose. This may include the purchase of a thermal fogger, insecticides, and operating costs for the machine.

Supporting DHF Clinical Management Training Courses

The high case fatality rates associated for dengue hemorrhagic fever illustrate that hospital and health center staff need to recognize potential serious signs and symptoms, as well as be able to make clinical management decisions that can save lives. Many seriously ill patients will need to be immediately referred to the provincial hospital, but since that may not be practical, at all times, front-line clinical staff need to be better trained to take emergency and life-saving measures. The NT2 Project should provide funds for appropriate DHF clinical management training opportunities for district hospital and health dispensary personnel.

Supporting the Procurement and Re-impregnation of Insecticide Treated Bed Nets for Selected Target Populations in the NT2 Project Intervention Area

It may not be practical for the NT2 Project to provide funding to purchase insecticide treated bed nets for everybody in the NT2 Project intervention area. The project should, however, consider this procurement for all construction workers [if their dormitory sites do not have adequate screening on windows and doors], re-

settlement communities, and for indigent families in the NT2 Project intervention area. There can be several modalities involved, such as subsidizing the entire purchase cost or establishing a fund which recipients eventually repay over a specified time period. The bed nets should be of LLN variety, which can last if properly maintained for 5-6 years. LLNs are impregnated with insecticide during the production process, and accordingly do not have to be re-impregnated for another 5-6 years. For households, which already have IBNs, the NT2 Project should support annual re-impregnation activities. Those nets that are no longer in a usable condition, should be replaced with LLNs, so that eventually all bed nets are of the LLN variety. The NT2 Project may similarly wish to establish a “supplementary IBN fund” for households who need additional IBNs for certain family members sleep in temporary huts adjacent to their rice-fields when they are involved in planting, weeding, and harvesting activities. This will ensure that all members of the household are protected against malaria no matter where they are sleeping. This intervention should be discussed and coordinated with district, provincial, and national Malaria Control Programme personnel

Supporting the Procurement of Artemisinin-based Combined Therapy (ACT) for Falciparum Malaria Patients

With the increased resistance to chloroquine and sulfadoxine-pyrimethamine, the NT2 Project should consider procuring adequate supplies of ACT for the treatment of falciparum malaria cases. This intervention should be discussed and coordinated with district, provincial, and national Malaria Control Programme personnel.

Supporting the Procurement of Rapid Diagnostic Tests for Falciparum Malaria Patients

A key strategy that has led to a dramatic reduction in malaria, has been early diagnosis and adequate treatment (EDAT) of confirmed, or suspected, cases. The project should provide financial support for the training of district hospital staff/laboratory technicians and village-level health/malaria workers, at dispensaries and in at-risk communities, to properly use rapid diagnostic test kits [dipsticks] to confirm falciparum malaria and accordingly immediately commence appropriate treatment. This intervention should be discussed and coordinated with district, provincial, and national Malaria Control Programme personnel.

There are other potential insect and animal-borne diseases, such as scrub and murine typhus, leptospirosis, and filariasis, but they are currently not endemic to the Lao PDR, or not serious public health issues. Construction workers may be at a higher risk of contracting scrub typhus, than the general population, but IEC campaigns at the work site, and prompt treatment of suspected cases are the most cost-effective ways of controlling/managing this issue.

7.2.5 Water Supply, Environmental Sanitation, and Related Communicable Diseases:

The overwhelming majority of people living in the various zones of the NT2 Project intervention area use potable water for drinking and other household purposes that derives from unsafe, or potentially unsafe, sources. Although principal water sources vary amongst zones and between communities, most people use ponds, rivers, streams, unprotected shallow dug wells, and rainwater. The quality of these water sources can considerably fluctuate during the year; with various contaminants and external matter entering water sources during the rainy season. In the dry season there is a danger that the concentration of potentially

harmful pathogens or contaminants increases, so as to make potable water less safe for consumption. The percentage of households with latrines remains very low throughout this geographical area. Most latrines are pit latrines. Very few are of the “hand” flush-toilet or water-seal variety, which are more effective to use as there is less chance for human wastes to contaminate the immediate environment. In addition to the lack of latrines, general environmental sanitation conditions in and around the house are often conducive for the spread of a wide range of water and soil-borne pathogens. Hence it is not surprising that most villagers, regardless of age, have intestinal parasitic infestations [e.g. roundworm, hookworm, pinworm, etc.], and are susceptible to frequent bouts of diarrhea.

Opisthorchiasis, a trematode disease, caused by a liver fluke is exceedingly common in all parts of the NT2 Project intervention area, except for the Nakai Plateau. Although most infections are mild, the pathogen colonizes and obstructs the bile duct, causing jaundice and possibly leading to cirrhosis, enlargement and tenderness of the liver, as well as progressive liver damage. Eating raw or undercooked fish and crayfish is the means of transmission. The adult worm subsequently deposits eggs in the bile duct, which is then evacuated in feces. If the feces enters a water source, the parasite will initially invade an appropriate intermediate snail host and develop into a larva. The larva leave the snail and invade a second intermediate host (certain species of fish and crayfish), where they enter the muscle and encyst. The cycle is complete when another person eats the infected fish raw or undercooked (e.g. in *laab* or *goi*). Opisthorchiasis is probably the most prevalent parasitic infestation in the NT2 Project intervention area. Although there are many campaigns to convince people to change their “eating habits”, the only practical means to alter this situation is to expand latrine use to all households and to provide chemotherapy to infected individuals [i.e. the drug *praziquantel*].

The NT2 project has conducted several intensive studies to determine whether schistosomiasis could potentially be introduced into the NT2 Project intervention area. The opinion of leading entomologists and communicable disease experts is that although the snail vectors are present in the NT2 Project intervention area, it is extremely unlikely that this serious illness can be established outside of its only known foci in the Lao PDR (i.e. Khong District in Champassack). Although the snail vector thrives in many locations in the Mekong River, and on some tributaries it has never established itself in human populations outside of Khong District. Construction and use of latrines, and treatment with *praziquantel*, are the best ways to prevent as well as treat and eradicate the disease.

As previously mentioned in this report, the quality of potable water may potentially decrease during the early period after the COD, as water-volume downstream from the power station, regulating and holding ponds, and downstream channels increase and erode riverbanks. This will increase the amount of sediment in the river, as well as adversely affect natural springs and wells alongside the riverbank. The NT2 Project Social Development Plan outlines a variety of mitigation strategies to deal with such eventualities. The “Health Action Plan” includes an elaborate list of recommendations to improve water supply and environmental sanitation. This includes the implementation of a Khammouane provincial rural water supply and sanitation improvement project. This initiative would provide safe drinking water supplies to many communities at a fixed-rate of piped water, public taps, tube-wells, or protected wells per village. It would also determine an adequate supply of latrines per village. The action plan contains recommendations for the provision of safe drinking water supplies, and latrines, to individual households in the resettlement villages, as well as for camp- sites

and potential camp follower settlements. It is a very comprehensive plan that includes health education campaigns regarding fecal/oral transmission of diseases, and the transmission of helminthic infestations. It includes garbage disposal schemes and other inputs that would improve environmental sanitation and greatly reduce the incidence of diarrheal and other communicable diseases, currently prevalent in the NT2 Project intervention area. As such this, or a modified version of the, plan should serve as both “*business as usual*” and “*best practices*” strategies.

The NT2 Project may also consider doing the following:

Establishing a Latrine Construction Revolving Fund

It may be beyond the scope of the NT2 Project to provide financial support for the construction of safe water supply systems and/or the construction of latrines in every community in the project intervention area. This endeavor would also take many years. A relatively easier, and more cost-effective, approach would be to support the construction of latrines for every household. Many communities and households already understand the importance of using latrines to improve environmental sanitation and to prevent the transmission of diarrheal diseases and intestinal parasitic infestations. Many households simply do not have the financial resources to purchase materials to construct an appropriate latrine. The NT2 Project should consider, in consultation with local health officials, members of mass organizations, and district and village leaders, the establishment of a “latrine construction fund”. Depending upon decisions made at the village level, all families would be eligible for loans [in kind] to construct an appropriate latrine for their household. The time-frame for repayment of the loan, in cash, could vary depending upon the economic status of the borrower. Indigent families could be eligible for subsidized materials, but may have to contribute additional labor, depending upon decisions and agreements made at the village level. Repaid loans could either be returned to the NT2 Project, or remain as an on-going “revolving fund” for future village-level latrine maintenance and construction activities. The NT2 Project should support the construction of “water-seal”, or “hand-flush”, latrines as these are easier to maintain and have a longer life-use than “pit-latrines”. Latrine design, concerning floor, walls, roofing, etc. can vary but “water-seal latrine heads” should be attached to a cement foundation to ensure stability. Even if there is no major improvements made in the quality of potable water at the community level, the introduction and proper use of latrines, by all members of the household, will nevertheless have a dramatic effect on reducing the incidence, and prevalence, of diarrheal diseases and helminthic infestations.

Conducting “Improved Personal Hygiene” Campaigns

Poor personal hygienic practices contribute to the transmission of a wide array of communicable diseases, which are easily preventable. The NT2 Project should support health workers, village volunteers, and mass organizations [especially the LWU] to conduct “improved personal hygiene” campaigns for mothers in the resettlement communities, for other rural villages, and for school children. These campaigns should be of a participatory and demonstrative nature, rather than didactic lectures or speeches. Key issues to cover should at a minimum include, (1) the proper washing of hands with soap and water after defecating/urinating, and before serving food or eating meals; (2) regular trimming and cleaning of finger-nails; and (3) regular bathing [preferably at least once a day]. Active participation, in addition to being potentially enjoyable exercises, will allow all partici-

pants to demonstrate that they have learned new skills that will improve their health as well as perhaps that of other family members. It should be emphasized that a simple exercise like properly washing hands, after defecating/urinating, and before serving food or eating meals will dramatically reduce the incidence of diarrheal diseases and acute respiratory infections. This is especially relevant for young children, and the essential reason why mothers need to be taught these basic but potentially life-saving skills.

Conducting Food Safety and Food Preparation Inspection Campaigns

With the influx of a large number of construction workers and other migrants into certain sections of the NT2 Project intervention area, there will be an increase in the number of restaurants, food stalls, and markets preparing and handling food. These sites can potentially serve as focal points for the outbreak of water-borne diseases, as well as transmission points for foods containing intestinal parasites and/or pesticides. The NT2 Project should support local health authorities, mass organizations [e.g. the LWU], and other relevant agencies to monitor, on a regular basis, the quality of food sold in markets and at restaurants, food stalls, and other venues. Once again the campaigns should include participatory demonstrations to ensure that the target population acquires specific skills to reduce opportunities for communicable disease transmission. In addition to covering topics concerning “improved personal hygiene”, the inspection campaigns should cover the cleaning and handling of utensils used in the preparation and serving of food [e.g. pots, pans, plates, trays, glasses, spoons/forks/knives, cutting boards, water storage containers, containers used to wash utensils, etc.]. The course should cover the proper way to wash vegetables and meats before being cooked or served to ensure that potential pathogens and perhaps pesticides are not consumed. Those restaurants, food stalls, and other venues serving food demonstrating high hygienic standards should be presented with a formal certificate, which can be displayed in their establishment, attesting to their high food safety standards. Certificates should be presented annually to ensure that food safety and preparation standards are maintained. Those establishments that refuse to improve their food safety or preparation standards to a required level can be warned, fined, or closed down by the proper authorities. A similar campaign can be conducted in food markets and food stalls in district towns. Local authorities should support these efforts by providing all food establishments and market stalls with adequate supplies of garbage disposal baskets that are collected or emptied on a regular basis. Collection fees can be mutually decided upon between users and relevant government agencies.

7.2.6 *Other Relevant Health Issues*

Even if the above mentioned suggested “*best practice*” strategies are implemented successfully, many people in the project intervention area may still face a poor health prognosis. This is especially true for women of reproductive health and young children, living in remote areas, as the current health care delivery system is not able to properly address many of their immediate health needs. This report, and others, has illustrated the unequal distribution of health facilities and trained manpower between urban and rural areas, especially for remote ethnic minority communities. Without properly addressing this issue, health status will remain poor in these geographic areas. There may be less illness and death attributed to malaria, but women of reproductive age and young children may still become ill and die from preventable illnesses or conditions. Accessibility to contraceptives needs to be placed on a similar footing as that which was established for the distribution of insecticide treated bed nets. Increasing the availability of

contraceptives is the simplest means of reducing population growth and undue pressure on land and other local natural resources and social services. It is also the most cost-effective way to dramatically reduce maternal and infant mortality rates in a relatively short period of time. The technology is simple and user-friendly. It simply needs a more appropriate means of distribution to reach those in need, or wishing to receive, such services.

Two major constraints in improving health care for rural and remote areas concern accessibility and cultural acceptability. One of the reasons for this predicament is that the existing health service delivery system operates on a philosophy that promotes “facility-based health care”. What this means is that all potential clients and/or sick patients are required to physically travel to the district hospital or village health dispensary for services. While this may seem a logical approach from a medical perspective, it does not take into consideration that most people “in need” of basic health services are not ill. As such rural women will not necessarily take the time to travel far distances, by themselves or with their children, for ante-natal and post-partum examinations, contraceptives, and/or nutritional surveillance services when they have many other essential daily tasks to complete in and around their homes and fields. If the National Malaria Control Programme, followed a simply approach, rather than by making the distribution and re-impregnation of IBNs and the provision of EDAT available at the village-level, for all at-risk villages, it is doubtful whether that the incidence and prevalence would have declined to its present level. Contraceptives will probably save the lives of more women of reproductive age and infants than IBNs and EDAT interventions, yet this health service has a much lower priority. Equally disturbing is the fact that very few health professionals even understand the association between contraceptives, birth-spacing, improved health for mothers and young children, and reduced maternal and infant mortality rates.

Some of the ways to improve this situation may be to adopt the following “*best practice*” strategies:

Establishing Special Scholarship Funds for the Deployment of Multi-Purpose Health Workers at Village Dispensaries

Although there are too few health dispensaries in rural and remote geographic areas, an equally serious problem is that those deployed to these village-level facilities do not have the pre-requisite skills to provide high quality care. This situation will not dramatically change, in the near future, even with greater regularity of additional in-service training opportunities for health personnel deployed to these sites. The NT2 Project may wish to establish, in consultation with district, provincial, and national health authorities a special “scholarship fund” to train multi-purpose health specialists to work at remote village level health dispensaries. Training can cover many topics, but it must up-grade midwifery/obstetrics skills, general clinical care, communicable disease prevention, and counseling services. The trainees can include existing health personnel from provincial or district hospitals, or even from the health dispensary level. Courses can be conducted at both the provincial and national level, as well as consist of overseas training opportunities designed to up-grade specific competency-based skills/aptitudes [e.g. pre-and post test HIV counseling, the clinical management AIDS, etc.]. Trainees must agree, beforehand, to be deployed to selected rural/remote health facilities for a period of 3-5 years. As such “scholarship fund” may need to include a reasonable “hardship allowance” to serve as an incentive for highly skilled health workers to remain at their post for the required time period.

Supporting Efforts to “Move Beyond Facility-Based Health Care”

Health authorities, at all levels, must be re-oriented to appreciate that improving accessibility to basic health care needs to include regular outreach, and/or mobile clinic, visits to rural and remote communities. There are too few patients, whether in-patients or out-patients, to justify having a large number of health personnel permanently based at static facilities. Better coordination needs to exist between vertical health programs [e.g. Malaria Control, Safe Motherhood, Birth-Spacing, EPI, etc.]. This will reduce operational costs and ensure that the same target groups have access to a wide range of comprehensive promotive, preventive, curative care services that *save lives*, and which can be provided in or near their homes. Regularly scheduled mobile/outreach care clinics, if implemented properly, can also serve as on-site supervisory and continuing in-service training sessions for village level health workers, volunteers, and traditional birth attendants. These visits will also promote greater local participation and involvement in the provision of basic health services at the community-level. The NT2 Project should promote the establishment of a team approach, which utilizes health professionals and members of mass organizations. The NT2 Project should support daily allowance and operational costs. These budgets should complement and expand upon existing local health action plans and available resources.

Supporting On-Going In-Service Training Education For All Level of Health Care to be able to Address New Emerging Health Issues and Problems:

This report has indicated that within a relatively short period of time the NT2 Project intervention area may be facing considerably different health problems and issues. Although this may initially include a marked increase in the number of people, and families, suffering the effects of a dramatic rise in the prevalence and incidence of HIV/AIDS, STIs, vehicular accidents, and mental health problems, it will eventually comprise a much broader range of health related issues. The Lao PDR will probably follow the same pattern witnessed by most of its neighbors in the region, such as Singapore, Taiwan, Malaysia, Thailand, and to a lesser extent China, Viet Nam, the Philippines, and Indonesia. Chronic and debilitating illnesses, associated with aging, life-style changes, and advances in medical technology, will promote the emergence of non-communicable diseases as the major cause of morbidity and mortality. These ailments are more difficult to treat or cure than the acute, and at times explosive, episodes associated with communicable diseases. For many patients treatment will never result in a cure. Similarly many of these individuals will need long-term follow-up care for many months, years, and/or for the remainder of their lives. The modalities employed to provide treatment to patients suffering from diabetes, hypertension, and cancer, for example, can be entirely different than that for dengue shock syndrome, profuse diarrhea, and other acute illnesses, both in terms of timeframe and the required types of medical and diagnostic equipment.

Health personnel, at all levels and at every health facility, need to be prepared to handle situations that may be substantially different from the ones they currently encounter. Health personnel will not acquire new health knowledge and skills by osmosis. They will need to be exposed to theoretical and practical training opportunities that provide them with a better understanding of the relevant issues involved, as well as a chance to develop and refine specific competency-based skills. The NT2 Project needs to anticipate, in advance, the realm of reasonable possibilities that may arise, and take the necessary measures to ensure that health personnel are ready to deal with these problems before they reach a criti-

cal point. As mentioned above the health picture in the NT2 Project intervention area will have already undergone certain major changes by 2010. By 2025 health workers will need a vast new array of skills, and medical equipment and supplies, to address a health scene dominated by non-communicable illnesses and conditions. As such the NT2 Project should consider developing a long-term health manpower plan that includes the provision of frequent on-going in-service training courses for the next 20-year period. This human resource development plan should cover all categories of health workers and village volunteers. It is also imperative that this plan include a special "scholarship fund" for post graduate studies in the fields of internal medicine, cardiology, urology, obstetrics-gynecology, radiology, surgery, and laboratory technology. Since many of these specialized services will not be available at the district level by 2010, and even perhaps by 2025, training opportunities need to be opened for provincial level health personnel. The NT2 Project may wish to explore whether a special "scholarship fund" can be developed to increase the quota for various categories of health personnel and specialists who could be trained [from the pre-service level on upwards through post-graduate studies] for future deployment to the NT2 Project intervention areas. Many types of post-graduate medical-health specialty training programs are currently available in Vientiane. Some trainees should, however, be eligible for long and short-term training opportunities at international renowned institutions in the region.

8 CONCLUSION:

The preceding sections have outlined a number of potential cumulative health impacts that may reasonably be expected to develop as the result of a combination of Nam Theun 2 Project interventions, and other external macro and micro-economic development schemes, during the periods 2005-2010 and 2010-2025. As one moves away from the present, and travels further into the future, there is obviously a greater chance that prophecies or predictions do not material. There are simply too many unknown factors. However many of the predicted scenarios, are based upon current and future development plans, as well as on the observation and experiences of how similar large scale infra-structure and general economic development projects, in neighboring countries, have affected health on a local, national, and at times regional basis.

This report has suggested that the most dramatic potential cumulative impacts may arise as a result of external factors, such as urbanization and migration, and not necessarily from some of the sector developments created by the Nam Theun 2 Hydropower Project [e.g. hydrology]. The convergence of a large work force, accompanied by perhaps thousands of camp followers and other migrants, to various localities in the Nam Theun 2 Project intervention will create conditions conducive for a substantial and perhaps explosive increase in vehicular accidents, STI & HIV/AIDS, and certain communicable diseases. The potential increased movement of ethnic minority communities, first as part of the planned resettlement scheme, and subsequently involving other developments on the Nakai Plateau and elsewhere may lead to a rapid breakdown in tradition values. Increased tension and conflict may develop between household members, especially those of different generations. Increased levels of stress will promote the onset of mental health problems. A large exodus of ethnic minority adolescents and young adults to Nakai and nearby district towns, and/or to other urban cen-

ters in the Lao PDR or Thailand, can also exacerbate feelings of disorientation and depression, which may result in alcohol and drug abuse, and other self-destructive behavior. The present health care delivery system is not prepared, or experienced, to handle any of these issues.

The Nam Theun 2 Project, in combination with other economic developments, such as the East-West Corridor, Savannakhet SEZ, and transnational bridges and thoroughfares closely linking the Lao PDR with Thailand and Vietnam, may also dramatically impact on population growth for the entire Central Region. Population growth rates are influenced by many diverse factors. At the most basic level population growth rates reflects the difference between the number of people being born, and those who are dying, in a particular area over a finite period of time [usually 12 months]. Thus if there are more births than deaths, a population will grow. Although low population growth rates are usually associated with a number of positive factors, they do not necessarily imply that the population in question is healthy. Many countries in Sub-Saharan Africa have very low population growth rates, but this is due to the tremendous number of HIV/AIDS deaths and not to high levels of contraceptive prevalence, low crude birth rates, low fertility, and other variables generally associated with a healthy population that has access to high quality basic health care services. A similar situation can develop in the NT2 Project intervention area with an explosive HIV/AIDS and vehicular accident epidemic.

Crude birth rates are also dependent on many variables that include the demographic age composition of the population, as well as several inter-related issues that influence the determinants of fertility for women of reproductive age. This can include median age at first marriage, age at the time of first sexual intercourse, marital status, percentage of eligible women using contraceptives, the desire for more children, and unmet need for contraceptives. Many of these variables can change over-time, but the large scale migration of adolescents and young adults out of rural communities and into urban areas in seek of employment have the potential to considerably speed up this process. Migration may positively interfere with certain variables, while negatively affect others. Many adolescents and young adults may either delay the time of their marriage, or will live away from spouses for extended periods of time. For the latter, this can act as a brake on high fertility rates. Migration may also positively affect fertility for those who are not married. Up until now the age of first sexual intercourse contact [for women] was closely associated with age at first marriage. Delaying the time of marriage could similar decelerate the number of births; especially for adolescents. On the other hand migration to urban areas, where many young women will not live with family members or relatives, can possibly lead to an increased onset of first sexual intercourse contact. It may also lead to higher rates of abortion, maternal mortality, as well as HIV/AIDS and STIs.

Depending upon the extent of the migration, from remote and/or rural areas, into district centers and urban areas, population growth may considerably decline locally [i.e. at the village level], but increase in, or be transferred to, other geographical locations. This process can lead to severely unbalanced, or unhealthy, economic growth as basic social services will be inadequate to serve the needs of a burgeoning urban population. Some of these issues are clearly outside the realm of the Nam Theun 2 Project. The project, itself, will not be able to establish measures to mitigate against such developments, the way it can for an increase in sediment leading to a decrease in water quality as a result of hydrology issues. Interventions need to take place at the national level. However dramatic potential impacts can nevertheless be felt at the household and community level. Who will

replace the “productive members” of a family or community, once a sizable proportion of these individuals migrate elsewhere; or for that matter if they are seriously injured or die from vehicular accidents or HIV/AIDS? Who will provide the emotional and economic social support network for older and younger members of the community?

This report has outlined a series of what it refers to as “*best practice*” strategies. They are intended to be guidelines for future action in anticipation of potential developments that may impact on health. Most are meant to be pro-active in nature, hopefully stimulating discussions and prompt decisions, through a participatory process, and not waiting until serious problems emerge, and in a very short period of time possibly spin entirely out-of-control. Some deal with potential impacts on health expected during the period 2005-2010. This will primarily focus on ways to prepare local authorities, mass organizations, communities, and individuals for issues such as HIV/AIDS, STIs, vehicular accidents, mental health problems, pesticides, and emerging communicable disease problems [e.g. dengue]. The “*best practices*” also suggest ways to improve the technical capacity of the health care delivery system to effectively deal with current and new health issues, but more important they focus on ways to make health care truly more accessible and culturally acceptable. The “*best practice*” strategies also suggest ways to approach a new and vastly different health picture that will have evolved by 2025. One that will be dominated by chronic non-communicable rather than acute communicable diseases.

Discussions focused on planned health interventions for Nong Boua and other resettlement communities. On-site visit in Nong Boua included observations of newly constructed water and sanitation systems, house construction, as well as discussions with village health volunteers.

[A special note of appreciation is for Dr. Khamdone Volavong, senior staff member of the Mother and Child Health Center (MCHC)/MOH, in Vientiane who accompanied the consultant on the field-trip to Khammouane].

Documents: Additional information was gathered from the documents listed below

- “Nam Theun 2 Hydroelectric Project Impact Assessment and Public Health Action Plan”, Draft and Revised Reports, March 2004.
- “Baseline Survey Report: Health Services Improvement Project”, Ministry of Health/Work Bank, March 2004 (Volumes I & II).
- “Asian Development Bank Proposed Grant Assistance (Financed from the Japan Fund for Poverty Reduction) to the Kingdom of Cambodia, Lao People’s Democratic Republic, and Socialist Republic of Viet Nam for Community Action for Preventing HIV/AIDS”, April 2001.
- “The Study on the Improvement of Health and Medical Service in the Lao People’s Democratic Republic: Lao Health Master Planning Study”, Progress Report I, September 2001, MOH Technical Working Group and JICA Study Team.
- “The Study on the Improvement of Health and Medical Service in the Lao People’s Democratic Republic: Lao Health Master Planning Study, Progress Report II”, February 2002, MOH Technical Working Group and JICA Study Team.
- Monti, Feliciano, Mission Report for WHO Regional Office for the Western Pacific, “Malaria, Vector-borne and Other Parasitic Diseases”, Lao PDR, March 2004.
- Report on National Health Survey: Health Status of the People in Lao PDR, Ministry of Health/National Institute of Public Health and the State Planning Committee/National Statistical Center, January 2001.
- Lao-EU Malaria Control Project, “Part II Final Technical Report July 1997-2002: ‘The Mosquito is More Powerful than the Tiger’ “, December 2002.
- European Commission, Final Evaluation Mission of the European Commission Regional Malaria Control Programme in Cambodia, Lao PDR, Vietnam (Project Number ALA/95/13), Draft Report Second Version, December 2002.
- Coordinated Country Proposal, “Prevention and Control of HIV/AIDS/STI, TB, and Malaria in the Lao PDR, Submitted to the Global Fund for AIDS, Tuberculosis, and Malaria, 8 March 2002.
- Lao Reproductive Health Survey 2000, UNFPA Project Lao/97/P07, National Statistics Center and United Nations Population Fund, 2000

- Lao Reproductive Health Survey 2000, Summary Report of Provincial Data Analysis, Lao/02/P07, National Statistics Center and United Nations Population Fund, 2003.
- Labour Migration Survey in Khammuane, Savannakhet, and Champassack 2003, Ministry of Labour and Social Welfare/Department of Labor and the Committee for Planning and Co-operation/National Statistical Center.
- “The Study on the Integrated Regional Development Plan for the Savannakhet and Khammuoane Region in the Lao People’s Democratic Republic”, Final Report Part I Main Report, Part 2 Sector Report, Japan International Co-operation Agency, and the Committee for Planning and Cooperation/Lao PDR, September 2001.
- “Development Vision and Cooperation Programs for the Cross Border Region”, Final Report, JICA, Committee for Planning and Cooperation/Lao PDR, and the Office of the National Economic and Social Development Board/Thailand, September 2001
- Lohachit, Chantima, “Freshwater Snails in the Nam Theun 2 Project Area of Khammouane and Bolikhamxai Provinces, Lao PDR, April 1997
- Storey, John, “Surveys for Malaria, Anopheles Mosquitoes and Aquatic Snails in Selected Villages of Nam Theun 2 Project Area, Khammouane Province, Lao PDR, 19-26 March 1997”, April 1997.
- Storey, John, “Additional Study on Public Health of Nam Theun 2 Project, Lao PDR”, March 1997.

(John Storey also provided the Cumulative Impact Assessment investigating team with original notes and files concerning a health status assessment exercise he conducted in March 1996 for selected villages in the Nam Theun 2 Project Area. He also provided files and notes on various segments of the health section portion of the EAMP Report 1997).

- Polsena, Khamliene, Hongvanthong, Bouasy, Vanisaveth, Viengxay (IMPE/Lao PDR) and Promkutkao, Choomnoom (Fac. of Medicine, Chiang mai University/Thailand), “The Health Status of Resident Populations in the Nam Theun 2 Project Area, Khammouane Province, Lao PDR, April 1997.
- Sparkes, Stephen, “Observations Relating to the Resettlement of People on the Nakai Plateau”, May 1997.
- Chamberlin, James, Alton, Charles, Silavong, Latsamay, and Philavong, Bounleng, “Socio-Economic Cultural Survey”, for the Nam Theun 2 Project Area, July 1996 (conducted by CARE International/Lao PDR).
- MacDonald, M. “Nam Theun Social & Environmental Project (NTSEP) Identification Mission Public Health Aspects, May 1997.
- “Report on the Health Check-Up of Population in Pilot Village (Ban Nong Bua, Sailom, Pamanton) Nam Theun 2 Project Area 26 February-2 March 2001), March 2001.
- Nam Theun 2 Hydro Project Environmental Assessment for Construction Phase Activities: Information Prepared by Turnkey Contractor, 1997.

- Nam Theun 2 Project, “Xe Bang Fai Strategy Paper”, Draft-Revision C, 17 November 2003.
- Nam Theun 2 Hydroelectric Project, “Social Development Plan, Volume 1: Ethnic Minority Development Plan”, Draft, 15 December 2003.
- Nam Theun 2 Hydroelectric Project, “Social Development Plan, Volume 2: Resettlement Action Plan”, Draft, 15 December 2003.



REFERENCES

The references for this report derive from discussions with government officials and health experts, in Vientiane, as well as with provincial and district health authorities at the Khammouane provincial health office, and the district health offices in Nakai, Nhommalat, Mahaxay, Nongbok, and Xebangfai. Brief discussions were also held with NTEC Office and government officials in Nakai District as well as with extension workers and village leaders/health workers in the model village of Nong Bua.

Discussions: Key Informants

- Dr. John Storey (Public Health Consultant/MOH, Former Senior Adviser to the “Lao-EU Malaria Control Project”, and Short Term Health Consultant to the NT2 Project from 1996-2001) and Dr. Bouasy Hongvanthong (Former Director of the “Lao-EU Malaria Control Project” and the Deputy Director of the Center for Malariology, Parasitology, and Entomology): concerning the control and prevention of malaria, dengue, opisthorchiasis, schistosomiasis, and other vector-borne diseases, as well as the issue of the re-introduction of malaria in Nakai and Nhommalat districts with the influx of construction and migrant workers.
- Dr. Chansy Phimphachanh (Director of the National Committee for the Control of AIDS) and her staff: concerning the current HIV/AIDS situation in the Lao PDR, future plans and initiatives to prevent and control the spread of HIV/AIDS, as well as the creation of potential “hot spots” for STIs and HIV/AIDS transmission in the NT2 Project intervention area.
- Dr. Bounpheng Philavong (Dep. Director of Health Services Improvement Project/MOH preparation phase) and Mr. Peter Miller (Coordination Unit/MOH): concerning objectives of the HSIP and potential coordination between the HSIP and the NT2 Project in Nakai and Nhommalat districts.
- Mr. Bounthavy Sisouphanthong (Director General of Cabinet, Committee for Planning and Cooperation, and former Director of the National Statistical Center): concerning macro and micro-economic development plans for the PDR (especially in Khammouane, Savannakhet, and Bolikhamxay), with projections on how these initiatives can affect migration, urbanization, population growth, and disease patterns in the Central Region of the Lao PDR.
- Dr. Choum Chomechaleun (Director of the Khammouane Provincial Health Office), Ms. Somvang Thepavong (Acting Head of the Provincial MCH Dept.), Dr. Viengkham Keothongdee (Deputy Director of the Nakai District Health Office), Dr. Namchai Utsa (Deputy Director of the Nhommalat District Health Office), Dr. Sipaseut (Director of the Mahaxay District Health Office) and staff, Dr. Inthong Hanpaseut (Director of the Nongbok District Health Office) and staff, and Dr. Bounbang Manivong (Deputy Director of the Xebangfai District Health Office) and staff: concerning existing health problems, as well as potential impacts of the NT2 Project on health.
- NTEC Project and GOL officials working in Nakai District and the Nong Boua model village, as well as village leaders and village health workers in Nong Boua. This included Mr. Hoei Phomvisouk, Ms. Keo-oula Souliyadet, Ms. Napha, Mr. Thongkeo, Mr. Khamvieo, Mr. Khamfong, Mr. Sieng, and Ms. Hai.



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ASSESSEMENT AND NAM THEUN 2 CONTRIBUTIONS



Annex 7: Drugs and Human Trafficking

Prepared by: Jens Laugen

November 2004

TABLE OF CONTENTS

1	DRUG ABUSE AND TRAFFICKING.....	1
1.1	Regional Perspective	1
1.1.1	Myanmar	1
1.1.2	Cambodia.....	1
1.1.3	Thailand	1
1.1.4	Vietnam.....	2
1.1.5	Programmes and Initiatives.....	2
1.2	National Perspective	3
1.2.1	Institutions and Programmes	3
1.2.2	Opium Poppy Cultivation and use	4
1.2.3	Amphetamine Type Stimulant (ATS) Drug Production and Abuse	4
1.2.4	Drug Trafficking.....	5
1.3	Local Perspective	5
1.3.1	Opium Cultivation and Use	5
1.3.2	Amphetamine Type Stimulant Abuse	5
1.3.3	Drug Trafficking and Law Enforcement	6
1.3.4	Future Developments.....	7
1.4	Recommendations	7
2	MIGRATION AND HUMAN TRAFFICKING	8
2.1	Introduction.....	8
2.2	Regional Perspective	9
2.2.1	Thailand	9
2.2.2	Vietnam.....	9
2.2.3	Regional Initiatives and Programmes.....	10
2.3	National Perspective	10
2.3.1	Introduction	10
2.3.2	Legal and Institutional Framework against Trafficking.....	11
2.3.3	Studies and Research into Trafficking and Migration	12
2.3.4	Projects and Initiatives	13
2.4	Local Perspective	15
2.4.1	Labour Migration Survey.....	15
2.5	Future Developments.....	18
2.6	Recommendations	19

LIST OF TABLES

Table 1: Current Projects and Programmes on Human Trafficking in Lao PDR	14
Table 2: Provincial and Urban/Rural Distribution of Sample population	15
Table 3: Migrants by Sex and Age	16
Table 4: Distribution of Internal and Trans-border Migration	16
Table 5: Migrant Groups Considered at High Risk	17
Table 6: Percentage of Migrant Workers in different types of Employment.....	18

1 DRUG ABUSE AND TRAFFICKING

1.1 Regional Perspective

1.1.1 Myanmar

Myanmar was in 2003 the world's second largest producer of opium although area and production went substantially down in comparison to previous years. The Shan State, which forms part of the Mekong Basin, accounts for approximately 52 percent of Burma's total opium poppy crop (State Department, 2004) Myanmar is purportedly also the primary source of amphetamine-type stimulants (ATS) in Asia, producing hundreds of millions of tablets annually.

There are indications that Myanmar is experiencing a growing domestic market for ATS, mainly among youths who use it as a recreational drug. In addition, the country has a considerable opium and heroine abuse problem. Government figures puts the number of registered drug addicts at around 70,000 while UNODC surveys suggest that the addict population may be as high as 300,000 (State Department, 2004). Although a high figure this represents less than 1% of the population. Out of these up to 135,000 are regular users including 30,000 intravenous drug injectors. This is thought to contribute significantly to Myanmar's increasing HIV infection rates and AIDS epidemic.

1.1.2 Cambodia

Due to climatic limitations Cambodia is not an opium producing country, nor is opiates, like heroin, thought to be produced inside the country. There are indications and suspicions, however, that Cambodia serves as a transit route for heroin to the international drug markets. The UNODC estimates that 10 to 20 kilograms of heroin are trafficked through Cambodia daily (State Department, 2004).

Amphetamines are also increasingly being transited through the country. An estimated 100,000 methamphetamine tablets enter Cambodia each day, the major part of it most probably destined for the Thai market. There are also suspicions that foreign crime syndicates have set up mobile laboratories within Cambodia to produce ATS for local distribution and export to Thailand.

Cambodia has a considerable production of marihuana although there exists no reliable figures on the current size of the crop. However, some estimates put the production at more than 1,000 tons annually, most of which is cultivated for export. Much of the cultivation occurs in Cambodia's northwest provinces and is reputed to be "contract cultivation". Analyses of seizures indicates that Europe is the major destination for the exported cannabis.

1.1.3 Thailand

Thailand is not a significant producer of opium poppy any longer and little or no heroine is thought to be produced within the country as laboratories has not been discovered for years. The production of ATS is also thought to be fairly limited although Thailand is judged to have the most severe amphetamine addiction problem in the word. Most of the ATS consumed in the country is produced in Myanmar and smuggled across the border or via other neighboring countries. ATS abuse is so prevalent across different social groups and geographical regions in the country that the government perceives it as a national security prob-

lem and a major health threat. This prompted a national campaign in 2003 aimed at suppressing ATS trafficking and abuse. The campaign has had significant effects in reducing trafficking and availability of the drug as well as putting more resources and efforts into demand reduction through campaigns, detoxification and rehabilitation of addicts.

The major part of ATS, heroine and other illegal drugs smuggled into Thailand is destined for the domestic market though some quantities are thought to pass on to other countries and destinations. The extent of these transit shipments cannot be estimated with any accuracy.

1.1.4 *Vietnam*

Opium poppy cultivation is still taking place in the northwestern part of the country but only on a much reduced and limited scale accounting only for about 1 % of the total production in Southeast Asia (U.S. State Department, 2004). In the southern part of the country marihuana is grown and anecdotal evidence suggest that cultivation is done on a commercial scale. Drug production is not perceived to be a significant problem but there seem to be some ATS production within the country as a limited number of seizures of amphetamine pills and production equipment has been made. There are no indications that larger heroine factories exist within the country.

Vietnam is first and foremost a country into which drugs are smuggled and trafficked through. This is indicated by a number of heroine seizures that can be traced back to Vietnam in Taiwan, Japan, Hong Kong and Australia. Drugs are also trafficked into the country to feed the considerable addict population of heroine injectors and the increasing number of people, particularly urban youths, who use amphetamine as a recreational drug. ATS has thus increasingly become available in Vietnam and part of ATS available on the market is thought to come across the border from Cambodia.

Most drugs, in particular heroine and opium, enter via the northern part of Vietnam and is transported to Hanoi or further down through the country to Ho Chi Minh City from where they are shipped out destined for the drug market in Asia and Australia.

1.1.5 *Programmes and Initiatives*

Since 1993, when a Memorandum of Understanding between some of the the governments of the Mekong Sub-region on illicit drug production, trafficking and abuse was signed, the region has seen increasing coordination and cooperation in the fight against drugs. A direct result of the MOU was the Sub-regional Action Plan approved by the 6 governments of Cambodia, China, Lao PDR, Myanmar, Thailand, Socialist Republic of Vietnam in 1995 and amended in 1997 and 1999. It provides a strategic outline for the collaboration between the 6 signatory governments in addressing the problems of illicit drug production, trafficking and abuse in the region. The Action Plan focuses on demand reduction, alternative development and supply reduction as well as law enforcement and control measures. The Regional UNODC Office in Bangkok plays an important role in the implementation of the plan as a facilitator and coordinator.

Within the framework of the Action Plan, UNODC has supported and coordinated drug control activities focusing on broad based and long term programmes, and assisted in strengthening collaboration between the various national institutions

and agencies involved in the suppression of drug production and trafficking. The result has been a strengthening of bilateral policy level agreements for better co-operation between MOU countries, establishment of field level cross-border co-operation in law enforcement, demand reduction and supply reduction, and increased opportunities for control of cross-border trade.

1.2 National Perspective

1.2.1 *Institutions and Programmes*

Although having a far lower production than Myanmar Lao PDR is still the third largest producer of opium in the world both in terms of area cultivated to opium poppy and output of raw opium resin. The country also have sizable opium addict population in its northern part as well as a rising number of, in particular, adolescents and youths taking ATS as a recreational drug, subsequently falling into addiction.

The fight against drug production and addiction in the country is overseen by the high level Lao National Commission for Drug Control and Supervision (LCDC), responsible for organising and coordinating the Governments efforts to suppress use and production of drugs in the country. At central level it is composed of representatives from ministries and agencies that has some role to play in the fight against drugs such as the Ministry of Health, the Ministry of Education and the Ministry of Agriculture and the Prime Minister's Office. A permanent Secretariat provides administrative support and coordinates internal and international drug control efforts.

A National Drug Control Programme was developed and launched in 1994 through a cooperation between LCDC and the United Nations Office for Drugs and Crimes. The main objectives are:

- gradual elimination of opium poppy cultivation;
- elimination of cannabis cultivation;
- elimination of drug trafficking, refining and drug related crimes;
- drug demand reduction and prevention;
- control of psychotropic substances and precursors, and
- facilitation of international cooperation.

Within the National Drug Control Programme the "National Programme Strategy for a Balanced Approach to Eliminate Opium in the Lao PDR" was launched in 2000 aiming to largely rid the country of opium poppy cultivation by the year 2006. In connection with the Programme Strategy a project facilitation unit was established by the UNODC and LCDC charged with coordination and technical backstopping of the opium suppressing activities in the 11 northern provinces and special zone that presently cultivates opium.

In addition to LCDC drug control units have been established within the Ministries of Education, Health, Agriculture and Information. Provincial Committees for Drug Control have also been established in the opium producing provinces while District Committees for Drug Control have been formed in most of the 82 opium producing northern districts to support and coordinate drug control activities.

For law enforcement purposes Counter Narcotic Units have been established in 11 selected provinces under the Ministry of Public Security. The unit nearest to the NT2 Project Area is located at Savannakhet. However, in spite of these positive development with regard to law enforcement it is a fact that counter narcotic

initiatives and activities suffers from lack of resources in terms of staffing, training, equipment and operation thus reducing the efficiency of the agencies charged with control of cross-border trade and drug suppression.

Lao PDR has acceded 2 important UN conventions on Drugs, the 1961 “Single Convention on Narcotic Drugs” and the 1971 “Convention on Psychotropic Substances”. The country is not yet a party to the 1988 UN Drug Convention but strives to meet its objectives. Concerning national legislation on drugs the article 135 of the Penal Code was amended to outlaw cultivation of opium in 1996 and again in 2001 to include penalties for the production, trafficking and possession of ATS. At the same time the penalties for production and trafficking of drugs were drastically sharpened including introduction of the the death penalty for trafficking of more than 500 grams of heroine and 3 kg of amphetamines.

1.2.2 *Opium Poppy Cultivation and use*

Opium poppy cultivation for the extraction of raw opium that subsequently can be processed into morphine and heroine, are only found in the 11 northern provinces of Lao PDR. Due to increased suppression efforts over the last decade the area of opium poppy cultivation has steadily decreased, down from 26,800 ha in 1998 to an estimated 12,000 ha in 2003 (UNODC, 2004). According to the official Lao government figures production area was even lower with just over 7,000 ha planted to opium poppies in 2003. Most of the opium is grown by ethnic minority groups in remote and poorly accessible mountainous areas in the northern provinces. Luang Prabang and Huaphan Provinces are the biggest producers followed by Phongsaly. Bolikhamsay is the smallest producer with an estimated area of just 74 ha in 2003.

Opium addiction in Lao PDR is associated with poverty and ethnic minority groups in the northern part of the country. The number of opium addicts reported by provincial and district authorities was around 30,000 in 2003, out of which 9,700 (32%) was over 60 years and around 5,600 (19%) were women. The Provinces with the highest number of addicts were Luang Prabang, Huaphan and Phongsaly. Probably due to fact that opium is becoming more scarce and expensive the estimated number of addicts have also declined over the last years.

1.2.3 *Amphetamine Type Stimulant (ATS) Drug Production and Abuse*

In contrast to opium ATS abuse is an increasing problem in Lao PDR. Recognising the problem the GoL adopted a National Strategy on Demand Reduction in 2003, aimed at reducing ATS abuse, particularly among the youth. A number of measures have been initiated including awareness raising through campaigns and introduction of drug reduction curricula in schools, establishment of treatment centres and surveys and data collection on to chart the size of the ATS problem. An ATS data collection and monitoring system will be set up in 2004 by the support of the UNODC. Before this database is established it is difficult to assess the ATS abuse problem in the different provinces country in terms of number of addicts. However, in general it can be stated that amphetamines are amply available both in rural and urban areas in Lao PDR and that there is a pronounced danger that the number of addicts will increase in the future.

ATS producing laboratories or factories has not been discovered for the last years and the Lao authorities are adamant that production does not take place in within the country. There are some suspicions, however, that ATS powder may

presently be imported and processed into tablets before being re-exported or sold domestically.

1.2.4 *Drug Trafficking*

Increasing seizures of drugs transported along roads and waterways indicate a trend of increasing trafficking in the country. According to Lao official figures, a total of 445 offenders in 226 cases were apprehended and 39 kg of heroine, 14 kg of morphine, 209 kg raw opium, 41 kg liquid opium and more than 1,200,000 metamphetamine tablets were seized in 2003. Some 4,500 kg of cannabis was also impounded.

The major part of drug seizures are occurring in the northern part of the country where drugs, most notably amphetamine and heroine, are smuggled across the border from the Shan State in Myanmar and transported to the Vietnamese and Chinese borders. It is mainly heroine that is trafficked into Vietnam, one important route going across the international border Phongsaly Province shares with Vietnam and further on to Dien Bien Phu. Some part of the drugs, especially amphetamine, is trafficked southwards destined for the growing internal market as well as for neighbouring countries. A considerable part of the amphetamines presumably goes across the Friendship Bridge to Thailand, while smaller quantities are transported southwards by road or air down to the southern provinces, in particular Champasack, where it is taken over the border to Cambodia. The southward trafficking has probably been much enhanced by the war of drugs campaign the Thai government carried out in 2003.

1.3 **Local Perspective**

1.3.1 *Opium Cultivation and Use*

Of the 2 provinces within which the NT2 Project is located only Bolikahamsay has any opium production. According to the 2003 UNODC opium survey there were 10 opium-growing villages in Khamkheut District that adjoins and overlap with the northern part of NT2 Project area and the Nakai Nam Theun NBCA. Viengthong District, situated to the north of Khamkheut and bordering the Zaisombon Spacial Zone, is the only other district with a history of opium cultivation. The production obviously varies from year to year as Viengthong was recorded cultivating 42 ha in 2002 and nothing in 2003 while Khamkheut had 74 ha in 2003 and no cultivation in 2002. In both cases the opium poppy areas are not significant and probably only cater for a minor part of the opium consumed by the estimated 552 opium addicts in the province. In other words, opium produced in the area is consumed internally and probably nothing is trafficked out of the country or to other areas. On the contrary, opium is probably trafficked into the province from the northern opium producing areas as some anecdotal evidence suggest. As is the case elsewhere in the country it is probably mainly the ethnic minority population that for a number of reasons, one of them being lack of health services, are afflicted by opium addiction problems.

1.3.2 *Amphetamine Type Stimulant Abuse*

Even if production of ATS is not taking place within or in the middle region the country supply of amphetamines is well established and most probably increasing. Of the central provinces surrounding the NT2 Project area Savannaket is probably the one worst afflicted by ATS abuse problems as it has the largest urban population. To counter the problem there are plans to establish a drug treat-

ment clinics and rehabilitation centre in Savannakhet. In Vientiane an ATS-treatment centre was established in 2002.

It may be assumed that the ATS problem is also affecting the young population in Thakek although there exist no studies and statistics to verify this. In Gnommalat and Mahaxay amphetamines must certainly be available but probably only in minor quantities and on an exceptional basis at present. The general impression is that amphetamines has not yet been spread so much out from the urban centres and into rural areas in the middle part of the country as it has in the northern part. However, Lak Xao in Boilihamsay may be an exception as it is lies on the trans-border Route 8 with a considerable traffic running through ferrying goods and people to and from Vietnam. This cannot be confirmed, however, as investigations and surveys are needed to assess the scale of the present ATS problem have not been carried out.

1.3.3 *Drug Trafficking and Law Enforcement*

Statistics of arrests and amounts of drugs seized by law enforcement agencies indicate that drugs are trafficked through Bolikhamsay, Khammouan and Savannakhet.

Bolihamsay had only 2 drug offence cases in 2002 in which 8 people were arrested for trafficking and possession of 784 kg of cannabis. In 2003 there were 18 drug offence cases involving 30 arrested and seizure of 11,5 kg of opium, 20,248 methamphetamine pills and 3,237 kg of cannabis.

Khammouan had 9 cases in 2002 with 7 arrests and seizure of 372 amphetamine tablets and 536 kg of cannabis. In 2003 there were 2 drug cases with 7 people involved while amphetamine tablet seizures had increased to 4,000. Seizures of cannabis amounted to 544 kg.

Savannakhet had 11 cases in 2002 with 22 arrested and 34,362 methamphetamine tablets seized. In 2003 seizures went down to 24,785 tablets in 6 cases with 23 arrests.

The statistics does not indicate how big a part of the seizures were made at border crossings, but it is reasonable to assume that a fair part was, as cross border cooperation and coordination between custom officers and counter narcotic police in Lao PDR and neighbouring countries is steadily improving. It may be speculated that a considerable part of the 2003 seizures in Bolikamsay of amphetamine tablets were made the Lao-Vietnam border crossing on Route 8 or along this road.

Under the UNOPS Sub-regional Programme and Action Plan financed by Japan several Border Liaison Offices (BLO) have been established on the Cambodian, Chinese, Thai and Vietnam borders. The BLOs are normally staffed by 5-6 police and custom officers and joint information exchange and planning meetings are held at normally 3 months intervals. There are plans to open a BLO at the Lao Bao border crossing on Route No. 9 in the near future and support for this is currently sought from the UNODC and other sources.

Apart from the BLOs the Counter Narcotic Units (CNUs), established in 11 provinces in the country, are important institutions in the suppression of drug trafficking. In the southern provinces CNUs have already been established in Champasack and Savannakhet. Important in the context of the NT2 Project is that a CNU office in Thakek presently is being established. Staff has already been des-

ignated and deployed in the anticipation that it will be officially opened in the near future.

1.3.4 *Future Developments*

In spite of efforts to prevent an increase in ATS abuse the number of amphetamine addicts may in the next few years increase substantially in the country as a whole. The large urban centres of Vientiane and the other major towns like Savannakhet and Pakse will most probably continue to be the areas worst afflicted by ATS abuse, but as in the northern areas, the drug will probably spread out and affect groups in rural villages and smaller urban centres also in the middle and southern part of the country.

In the NT2 Project area and surrounding districts ATS abuse will most likely, as a result of the increased transit traffic and influx of people, become more firmly established. The prevention efforts undertaken by the authorities and the NT2 Project under the Public Health Action Plan will contribute to slow down the increase in ATS abuse, but not be able to prevent it from happening. The strongest increase in ATS abuse is likely to occur in urban centres in the Lower Xe Bangfai area. Particularly in Thakek, that will experience a considerable increase in cross-border traffic, the abuse situation may have deteriorated to become similar to that in neighbouring areas of Thailand. Lak Xao and surrounding areas will also most probably experience a significant increase in ATS addiction mainly because of its location on Route 8 and increased transit traffic.

In Bolikhamxay opium production will most likely cease in the 2 districts that today have intermittent opium cultivation. It is likely, however, that the province will continue to have opium addicts among the ethnic minority population. These will continue to get their supplies of raw opium via internal trafficking routes from the northern part of Laos, including the Xaisombun Special Zone.

Heroin addiction will be most probably still be, as today, limited to a few individuals in the major urban centres of the country as the drug of choice will continue to be amphetamines. The NT2 Project area will thus most probably not be experiencing a notable heroin addiction problem.

Trafficking of heroin and amphetamine through the middle region of Lao PDR is likely to increase as demand in Vietnam is prone to continue to grow. The upgraded road systems across the middle part of the country, including Route 8 through Bolikhamsay, Route 12 through Khammouan and Route 9 through Savannakhet, will provide more opportunities to smuggle drugs, carried by couriers or hidden among the increasing shipment of goods.

On a longer term opium cultivation may be largely eliminated in Lao PDR. The opium addict population may also decline significantly, down to a few thousand. There is a risk, however, that opium addiction in the northern parts may be substituted by ATS addiction, affecting a much wider category of social groups. In the middle and southern parts of the country ATS addiction may develop to a serious problem, especially among youths. While still being dominant, ATS may also be complemented by a number of other synthetic drugs recreational drugs.

1.4 **Recommendations**

In connection with the NT2 Project the counter drug abuse measures should be implemented as a part of the Public Health Action Plan with a focus on the reset-

tlement area, the work camps and Gnommalat and Mahaxay district centres. It will be especially important to focus on schools and drug awareness raising for the students. A drug prevention curriculum already exist and is presently being introduced across the country. The education authorities in the project affected districts should be encouraged and supported to start using the curriculum as soon as possible.

In addition to prevention campaigns in camps and schools law enforcement need to be strengthened. It is recommended that contacts are made with the Counter Narcotics Unit (CNU) in Thakek which is due to be formally set up shortly. With assistance from the CNU measures to strengthen law enforcement in the area, especially in Mahaxay, Nakai and Gnommalat, should be planned and implemented as soon as the project activities get underway.

2 MIGRATION AND HUMAN TRAFFICING

2.1 Introduction

It is in general difficult to distinguish clearly between human trafficking and migration and there are many notions and views about what really constitutes illegal and exploitative trafficking. The “Protocol to Prevent Suppress and Punish Trafficking in Persons, especially Women and Children” gives the following definition: *Trafficking in persons shall mean the recruitment, transportation, transfer, harbouring or receipt of persons by means of threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of abuse of power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control of another person, for the purpose of exploitation. Exploitation shall include, at a minimum, the exploitation of the prostitution of others or other forms of sexual exploitation, forced labour or slavery or practises similar to slavery, servitude or the removal of organs.*

There are different perceptions or notions of the links between migration and trafficking among government authorities and organisations working with the issue of trafficking. Three of the most commonly held views are:

- Trafficking occurs as a more or less fixed percentage of migrants;
- Trafficking affects certain vulnerable groups of migrants more than others;
- Trafficking is in many cases not linked to migration;

All the statements can be said to be relevant as they probably capture the realities of migration in the region, describing situations that may be true to a certain extent or situations that are occurring in certain areas and in some settings.

Given the economic development and increasing economic integration the Mekong, entailing increased movement of good and people, trafficking is a phenomenon and problem that is growing. Therefore, governments, international organisations and NGOs are increasingly mounting different types of responses to combat it.

2.2 Regional Perspective

2.2.1 Thailand

In Thailand the leading institution working with human trafficking is the Bureau of Anti-Trafficking in Women and Children under the Department of Social Development and Welfare, Ministry of Social Development and Human Security.

The role and responsibility of the Bureau is to serve as a focal point for the coordination among the networks of concerned agencies for the protection and welfare of victims of trafficking. It is also charged with the responsibility to conduct relevant studies and analyses on human trafficking, and to provide welfare assistance, protection, and vocational development for women and children who are victims of human trafficking.

Thailand is a receiving, sending, and transit country for trafficked men, women and children. Within the country, women are trafficked from the impoverished Northeast and the North to Bangkok for labour and sexual exploitation. People who are trafficked are usually the rural poor, often belonging to ethnic minorities. As a destination country, Thailand receives trafficked women, children, and men from Burma, Cambodia, Yunnan Province of China, and Laos. Children are often trafficked to work in begging gangs while men end up doing farm, industrial, and construction labour.

Consciousness about human rights issues has risen since the new Constitution was drafted in 1996 (ratified in 1997). Trafficking has been addressed legally in the "Measures in Prevention and Suppression of Trafficking in Women and Children Act" (1997).

2.2.2 Vietnam

In Vietnam the responsibility for dealing with human trafficking lies with the "Department of Social Evils Prevention" in the Ministry of Labor, Invalids and Social Affairs (MOLISA). It is the focal point for of the Government's activities to combat trafficking. The Department is charged with formulating and implementing a National "Plan of Action to Combat Trafficking in Persons". Counter measures taken include increasing sentences for trafficking and increased investigation and prosecution efforts.

In Vietnam, the most pertinent law to counter the trafficking of women and children is the Criminal Code of 1985. In addition the 1992 Constitution has various provisions to support the rights of women and children, including Section 65, which states that, "Children shall enjoy protection, care and education provided by the family, the state and society." Furthermore, the 1991 Law on the Protection, Care and Education of Children has indirect provisions against trafficking.

Trafficking of women and children is a significant problem in Vietnam. There is a critical lack of solid statistical information and investigations into the problem but trafficking is generally believed to involve persons being trafficked both domestically and internationally for purposes of sexual exploitation, labour, forced marriage, and domestic servitude. The majority of trafficking victims in Vietnam are teenage girls and women trafficked into Cambodia from the southern provinces and into China from the northern provinces.

Within Vietnam itself, most Vietnamese trafficking victims are engaged in the substantial commercial sex industry that exists. Children and teenage girls in

southern Vietnam are particularly at risk for trafficking as prostitutes, primarily for work in brothels along the Vietnam-Cambodia border and in Phnom Penh.

2.2.3 *Regional Initiatives and Programmes*

A number of organisations, governments and international organisations are taking initiatives and implements programmes to combat trafficking in the region. These include the following:

- UN Inter-Agency Project on Trafficking (UNIAP) in the Greater Mekong Sub-region
- UNICEF East Asia Regional Project Against Abuse, Exploitation and Trafficking of Children
- The International Organisation for Migration (IOM)
- ILO Mekong Sub-regional Project to Combat trafficking in Children and Women
- The Australian Agency for International Development (AUSAID) - Asia Regional Cooperation to Prevent People Trafficking Project
- The Asian Regional Initiative Against Trafficking (ARIAT)
- UNESCO / Principle Regional Office for Asia and the Pacific (PROAP)
- COMMIT (Co-ordinated Mekong Ministerial Initiative against Trafficking): A conference is to be held in Yangon September 2004 between Thailand, Cambodia, China, Vietnam, Myanmar and Lao PDR to agree on measures and arrangements to combat trafficking in the region

2.3 **National Perspective**

2.3.1 *Introduction*

In the Lao PDR voluntary and irregular cross-border migration of people is widespread throughout the country, especially in the areas bordering on Thailand where extensive cross-border networks and contacts facilitates the finding of employment. Due to the irregular nature of the labour migration it is difficult to give any estimates of the present scale. The reasons for Lao citizens leaving their country to seek employment in Thailand, for longer or shorter periods of time, are manifold and complex. Poverty and lack of employment opportunities in their own country does not appear to be the only causes. The cultural factor also plays an important role as Thai language skills are widespread amongst the Lao population. Particularly after rice harvest when farm labour demands are low many Lao in the border areas use the opportunity to go for short term employment across the border to supplement family incomes, and to be able to satisfy their consumer aspirations. Among adventurous young people Thai culture and modern urban lifestyle may also constitutes a considerable attraction, representing an alternative to their present village life and prompting them to leave their farming duties to fulfil their visions of prosperity in the cities.

However, as previously noted, migration also constitutes a risk for ending up in a situation that clearly is abusive and falls under the category of trafficking as defined by UN. In areas close to the border, where there are extensive cross-border networks, people most often cross the border unaided utilizing their contacts and knowledge from earlier stays or from friends or relatives who have been there before. Agents (who are often well known and trusted) are sometimes used, but mostly avoided where possible due to their high fees. More remote areas are subject to the activities of agents. Where there is little knowledge of means to cross the border undetected and find satisfactory employment unassisted, a facilitator's services gives the impression of reducing the risk of being exposed. However it is under these conditions that villagers are most susceptible to fall victim to traffickers and end up in slave-like and exploitative situations.

2.3.2 *Legal and Institutional Framework against Trafficking*

Although there exist little information on the extent of trafficking across the country's borders human trafficking has been recognized as a serious and growing social problem by the GoL. The government agency that has been given the responsibility for preventing and following up human trafficking is the Ministry of Labour and Social Welfare (MoLSW) where the Social Welfare Department has established an office for "Child Labour and Assistance for Trafficked Women and Children". Of the mass organisations it is the Lao Women Union that has taken responsibility for human trafficking and reintegration of returnees.

A number of laws, decrees and international conventions provide the legal framework and legal instruments for addressing trafficking in Lao. Relevant laws and decrees include:

- Ministry of Public Security Decree No 110/97
- Prime Minister Office's Decree No. 031
- Lao Labour Law, 1994
- Law on Lao Nationality, November 1990
- The Lao Penal Code, 1990
- The Family Law, 1990

The Penal Code has provisions against violations of children's rights. This includes Sections 119-120, which protect children against sexual abuse, and Section 92, which penalizes the trade and abduction of children for ransom or sale. Article 69 also provides for penalties against individuals who mislead officials in sending people abroad or aid in illegal immigration.

The 1990 Family Law Decree dictates parental responsibilities towards children, and the 1990 Labour Law, updated in 1994, prohibits forced labour and protects the rights of women and children at work, the minimum working age being 15. The Government is also working on a "Law on Violence and Trafficking" that may be passed by the National Assembly in September 2004.

The Government of Lao PDR are party and signatory to a number of international conventions which are covering human trafficking either directly or indirectly. The most important include:

- UN Convention on the Rights of the Child

- UN Convention on the Elimination of all Forms of Discrimination Against Women
- Protocol to Suppress and Punish Trafficking of Persons, especially Women and Children, Supplementing the United Nations Conventions Against Transnational Organised Crime
- Un Protocol Against the Smuggling of Migrants by Land, Sea and Air
- UN Convention against Trans-national Crime

In addition to the international conventions against trafficking Lao PDR has already entered into one bilateral MOU with Thailand on labour migration. Another MOU with Thailand, entitled “Eliminating Trafficking in Children and Women and Assisting Victims of Trafficking”, is under preparation.

2.3.3 *Studies and Research into Trafficking and Migration*

A limited number of studies on migration and trafficking in the country have been undertaken. The most important include:

- How I Got Here: Commercial Sexual Exploitation of Children in Lao PDR, Ministry of Labour and Social Welfare, UNICEF, Vientiane, Lao PDR (not dated)
- Report on the survey and the situation regarding the trafficking of children in the Lao PDR, UNICEF (not dated)
- Trafficking in Women and Children in the Lao PDR – Initial Observations. UN Inter-Agency Project (UNIAP) – Ministry of Labour and Social Welfare, Division of Trafficking in Women and Children, Vientiane 2001;
- Labour Migration Survey in Khammouan, Savannakhet and Champasack 2003 Ministry of Labour and Social Welfare / Committee for Planning and Cooperation / ILO, 2003,

The MoLSW and UNIAP report, “Trafficking in Women and Children in the Lao PDR” studied migration and trafficking from Sayaboury and Saravanh provinces and points to a number of characteristics of the current migration patterns. Common characteristics of the migration to Thailand can be summarised as:

- Migration and movement rarely occurs out of pure economic need
- Movement across the border is mostly occurring on a voluntary basis but there are cases involving girls from Saravanh where coercion and force has been applied, and girls have allegedly ended up in slave-like working conditions in Bangkok or have been sold into prostitution
- Cultural traits may play a leading role in relation to migration and risk behaviour as young people are adventurous and find the idea of travelling to Thailand exciting

The report states that the reasons and logic for migration across the Thai-Lao Border is so strong that “it supersedes immigration laws and its force is such that police on either side is helpless to act against it”. It concludes that tightening of the border probably will not work as measure to prevent migration and trafficking.

The “Labour Migration Survey in Khammouan Savannakhet and Champasack 2003” is perhaps the report that currently provides the best information and in-

sights into trafficking and migration in the country. The finding and results are presented under 2.4-Local Perspective.

Due to the fact that so little is known about migration of trafficking more research is underway. Important upcoming reports on the subject are:

- a nationwide trafficking study undertaken by UNICEF
- a UNIAP qualitative based study of 30 villages entitled “TRACE: From Community to Exploitation”
- a study undertaken by the Save the Children UK, Lao Youth Union and MoLSW entitled “Migrant Children and Youth in Lao PDR: Migration Along the Border of Thailand”

2.3.4 *Projects and Initiatives*

There are a number of Organisations currently working on migration and human trafficking in Lao PDR. These projects represent an important resource base for acquiring information on trafficking and activities undertaken to combat it. In the following are listed projects that are ongoing or have recently been implemented in Lao PDR.

Table 1: Current Projects and Programmes on Human Trafficking in Lao PDR

Organisation	Project Designation	Location / target group
UN Inter-Agency Project on Human Trafficking in the Greater Mekong Sub-region (UNIAP)	UN Inter-Agency Project on Human Trafficking in the Greater Mekong Sub-region (UNIAP)	Various areas / Lao nationals at risk of trafficking
UNICEF	UNICEF East Asia Regional Project against Abuse, Exploitation and Trafficking of Children	Children of 10-18 years with special focus on ethnic minorities
Village Focus International (VFI)	Laos Anti-Trafficking (LATC)	Salavanh Province / Children and youth, repatriated young men and women
Save the Children UK	Participatory action research / capacity building Project to prevent trafficking	Children and youth at risk of trafficking in Luang Namtha, Bokeo and Sayaboury
Save the Children Australia (SCAU)	Youth at Risk	Children up to 18 years of age in Sayaboury Province
Norwegian Church Aid (NCA)	Project for Prevention of Violence against Women and Children	Xayphoutong District in Savannakhet
International Organization for Migration (IMO)	Return and Reintegration of Trafficked Women and Children (Lao component of a regional programme coordinated from Bangkok)	Bangkok, Vientiane, Lao PDR especially southern provinces
ILO - IPEC	ILO Sub-regional Project to Combat Trafficking in Children and Women	Lao nationals at risk of trafficking in Savannakhet, Khammouane and Champasack
Consortium in the Lao PDR	Prevention of Human Trafficking through Awareness Raising and Occupational Development in Mekong Border Communities	Sang Thong and Pak Ngeum Districts in Vientiane Municipality
Lao Women Union	Combating Trafficking and Violence against Women	Lao PDR
ACIL	Asia Regional Cooperation to Prevent People Trafficking	Strengthening of law enforcement against trafficking in the Lao PDR
UNESCO	Regional Programme on Research on Trade in Minority Girls from Yunnan, Myanmar and Lao PDR into Thailand	Lao PDR

In addition to the projects mentioned above “Give2Asia.org”, founded by the “Asia Foundation to Promote Philanthropy to Asia”, announced the launch of the first comprehensive women’s shelter and counselling centre for victims of violence and trafficking in Lao PDR. A national Plan of Action against Commercial and Sexual Exploitation of Children is also being prepared by the Lao Government.

2.4 Local Perspective

2.4.1 Labour Migration Survey

As noted above, there exist only a few studies that shed light on the issue of labour migration and human trafficking in Lao PDR. The most recent and comprehensive is a study undertaken by the Ministry of Labour and Social Welfare in cooperation with the Committee for Planning and Cooperation through the National Statistical Centre and with technical assistance from the ILO Mekong Sub-regional Project to Combat Trafficking in Children and Women (MoLSW/CPC, 2003). The study looks at the situation in 3 provinces in the middle part of Lao PDR, Khammouan, Savannakhet and Champasack. The sample population had a composition as shown in Table 2.

Table 2: Provincial and Urban/Rural Distribution of Sample population

Province	Urban	% ³	Rural ¹	% ³	Rural ²	% ³	Total	% ⁴
Khammouan	789	12.8	4,762	77.3	606	9.9	6,157	16.9
Savannakhet	4,043	21.9	9,627	51.9	4,876	26.2	18,546	51.0
Champasack	1,471	12.6	9,187	78.6	1,035	8.8	11,695	32.1
Total	6,303	17.3	23,576	64.8	6,517	17.9	36,398	100

1 Rural villages with road access; 2: Rural villages without road access; 3: Percentage of province sample; 4: Percentage between provinces

The ethnical composition of the sample population was dominated by the Tai-Kadai group (Lao Loum) with around 78% of the interviewed households, while the Austroasiatic group (Lao Theung) constituted around 22%. Only 0.2 % belonged to the Hmong-Yao group (Lao Soung).

Age and Gender Distribution

The results of the study indicates that a substantial part of the population migrate in search of employment to find work, and that women constitute a majority of the migrants. Of the female sample population 7.5% were found to migrate while the percentage of male migrants was lower with 6.2 %. Of the total migration population women constituted 55% while men accounted for 44%. However, there were considerable gender differences regarding age group composition and destinations as shown in Table 3 and Table 4. From 10 and up to 26 years the majority of migrants are female while above 26 there is a slight male dominance. It is especially between the age of 15 and 20 that the female majority is pronounced. Females in this age group makes up 28% of the migrant population while men only account for 16.1%.

Table 3: Migrants by Sex and Age

Province	<10	10-14	15-17	18-20	21-25	26-30	31-35	>35
Male	0.5	0.8	5.8	10.3	13.2	8.3	2.3	3.0
Female	0.2	2.9	11.4	16.6	15.1	6.4	1.9	1.3
Total	0.7	3.7	17.2	26.9	28.3	14.7	4.2	4.3

In relation to internal versus trans-border migration the study also found considerable gender differences as well as differences between the 3 provinces. The results show that men dominates the internal migration, especially in Khammouan, where it, in contrast to Savannakhet and Champasack, is the overall most common form of migration.

Table 4: Distribution of Internal and Trans-border Migration

Province	Inside Lao PDR			Trans-border		
	Male	Female	Total	Male	Female	Total
Khammouan	68	39	55	32	61	45
Savannakhet	17	9	12	83	91	88
Champasack	32	25	29	68	75	71

As can be seen from the figures Savannakhet and Champasack show a migration pattern that is predominantly oriented towards Thailand while Khammouan is more oriented to the internal labour market. Still, around 45 of the sample migrant population for the province migrate abroad for work.

Destinations

Those who migrate across borders to seek work are predominantly ending up in Thailand, although the study indicates that a considerable part of them goes on to other Asian counties or even Europe or America. Thus, 82% of the migrant population covered by the study found work in Thailand while 8.3 and 8.2 % ended up in other Asian countries and in America respectively. Only 0.5% ended up in Europe.

Education

In relation to education level among the migrants the study found significant differences between the provinces. Among those originating from Khammoauan around 18% had no education at all while the same figure for Champasack was 6.6%. Around 52% of the migrants had primary education and 25% had finished lower secondary school. There were also large differences in education level with regard to ethnicity. Whereas around 30% of the migrants belonging to the Austroasiatic group had no formal education only around 12% of those belonging to the Tai-Kadai group had no formal schooling.

Trafficking Risks

With regard to risk for exploitation and trafficking the study sought to access this through a couple of proxy indicators. It was suggested that those who kept in contact with the family and sent remittances were those who were least likely to be trafficked, and conversely, those who could not be contacted and never sent remittances were those who might have ended up in exploitative conditions that qualify as trafficking. The study found that 60% of the women and of the 47% of

the men sent remittances home while the overall figure for both genders was 55%. There were differences between age groups and between migrants of different ethnicity. There was a tendency that the percentage of migrants sending remittances increased with age and that a higher percentage of migrants belonging to the Tai –Kadai group sent more than those belonging to the Austroasiatic group.

Regarding the degree of contact migrants are kept with their families the study found that younger age groups could be contacted to a lesser degree than the elder age groups. There were also gender differences as women in general were less contactable than the men, Ethnicity was found to be a factor as the migrants from the Austroasiatic group kept less in contacts with their families than those of the Tai-Kadai group. This can, however, possibly be attributed to the unavailability of mail and telephone services in the villages they originate from.

Combining the above mentioned factors and that had elapsed since departure, the study assessed which age group could be considered as having the highest risk of being trafficked or exploited. The percentage of the migrants in an age subgroup where no information on livelihood could be obtained, no remittances had been sent and no contacts had occurred since departure were deemed to be at high risk. Not surprisingly, as shown in Table 5, the assessment found that the youngest female age groups from 10 to 18 years of age had the highest percentage of persons at high risk of being trafficked in to prostitution or slave-like working conditions.

Table 5: Migrant Groups Considered at High Risk

Migrant Group	Age	% of migrants with no info, contact or remittance		
		Male	Female	Total
10 - 14	-	-	3.2	3.2
15 - 17	-	-	1.8	1.8
18 - 20	0.2	0.2	0.2	0.4
21 - 25	-	-	0.4	0.4
> 26	-	-	0.8	0.8

Migrant Population

The survey also collected baseline information directly from village household registries and from the village authorities. This information provided additional insights into on the composition and activities of the migrant population. Overall in the 3 provinces the migrants constituted close to 4% of the sample population (women 2.4% / men 1.6%). The age composition of the migrants differed slightly between the provinces with Savannakhet having the youngest female migrant population with 31% being under 18 years of age, the corresponding figures for Khammaouan and Champasack being 27% and 21% respectively.

Types of Work

With regard to what type of work the migrants end up with information from the The Ministry of Labour in Thailand provides some insight. A registration of migrant workers from Lao PDR was carried out in September – October 2001 and comprised 59,358 individual workers.

Table 6: Percentage of Migrant Workers in different types of Employment

Type of Work	Male	Female	Total
Domestic work	2.6	25.8	28.4
Plantation work	6.7	2.9	9.6
Agricultural work (livestock)	4.4	1.5	5.9
Fishing	2.9	0.6	3.5
Construction	2.5	1.1	3.6
Porters in warehouses	1.1	0.4	1.5
Potteries	0.2	0.1	0.3
Rice mills	0.1	0.1	0.2
Mining	0.1	-	0.1
Unspecified with employers	19.6	20.2	39.8
Unspecified without employers	3.2	3.9	7.1
Total	43.4	56.6	100

Although the largest category in the registration was unspecified work, domestic work stands out as the dominant occupation for women while it for men was plantation work.

2.5 Future Developments

Given the economic development trends that are prevalent in the region there is reason to fear that migration will increase, and with it, trafficking, even though it may be argued that there is no fixed relationship between migration and trafficking, Countermeasures will most probably have some effect but will not be able to halt the increase of trafficking. As long as economic disparities prevail between countries and areas within a country labour migration will continue and along with it, trafficking. The demand for domestic workers and workers for sweatshop industries in the region will continue to be a driving force in the years ahead.

In a more local perspective the developments diverge a little from this general pattern. It should be noted that Khammouan differed somewhat from Champasack and Savannakhet according to the findings of the migration survey referred above. In Khammouan a larger percentage of the migrants traveled to other districts or provinces within the country. Given the advent of the NT2 Project and other industrial developments it may very well be that this tendency will reinforce itself as people will be attracted by the prospects of employment closer to their home. It is thus conceivable that the NT2 project will have a positive effect dampening cross border migration. On the other hand, the improved road system and increasing contacts with the outside world may lead to increased out migration of groups from the project area that are more susceptible and vulnerable to internal and cross-border trafficking. There is also a danger that trafficking or trafficking-like conditions may start to develop inside of the country, most notably in the Svannakhet and Khammounan provinces where the commercial sex and prostitution scene may develop further. In this respect NT2 will add to the economic growth and together with other infrastructure developments boost the regional economy so as to create conditions that are conducive for the commercial sex business, which again is linked to increased risk for trafficking.

2.6 Recommendations

The NT2 Project has not yet made an action plan for addressing human trafficking problems that may arise in connection with the project. Neither have any study on the occurrence of trafficking and migration in the area been carried out. It is recommended that a plan for preventing trafficking in connection with the NT2 construction activities is worked out by the Developer.

Although the NT2 Project can put measures in place that prevents and minimises trafficking in connection with workers camps the response to trafficking on the wider area need to be institutional. Law enforcement obviously needs to be strengthened and in this respect training and awareness raising within the police force would be a possible activity the NT2 project could sponsor. Furthermore the local Lao Women Union along with the Youth Union could be facilitated and strengthened through training and operational support so that a community mobilisation against trafficking can be initiated and sustained.

Since a national and regional framework for increased counter trafficking activities now are being put in place through bilateral MOUs and sub-regional initiatives this can be utilized in the context of NT2. For instance, the National Plan of Action against Commercial and Sexual Exploitation of Children currently under preparation, can also be utilised through local adoptions and targeted sponsorship of certain activities in the provinces and districts surrounding the NT2 Project.

Awareness raising activities need to be focused to be effective. This will mean targeting directly groups that are most in danger of becoming victims of trafficking. These groups will for instance include ethnic minority youth. In the resettlement villages and awareness raising should be supported through the education activities the NT2 Project will support.

In terms of law enforcement stricter border control to prevent migration and trafficking will be difficult due to the fact that the border is long and mostly unmanned. Instead targeting the facilitating persons involved in trafficking could be more feasible. Local law enforcement need to be strengthened and trained to for instance take action against recruiting agents coming into the area. Perhaps the most fruitful approach will be to raise awareness in the local communities and villages so that villagers themselves can protect their young population better. This should be incorporated in the social development programmes that will be implemented by the NT2 Project.

Traditionally, trafficking reduction interventions tend to focus on areas like income and employment generation to keep young people from leaving their village. These options should also be explored although the efficiency of these measures is questioned by some organisations and persons working to reduce the trafficking problem.

REFERENCES/BIBLIOGRAPHY

Chamberlain, Jim (2002) *Trafficking in women and Children in the Lao PDR – initial observations*. UN Inter-Agency Project – Ministry of Labour and Social Welfare, Division of Trafficking in Women and Children, Vientiane.

International Labour Office, by Christina Wille (2001) *Trafficking in children into the worst forms of child labour: A rapid assessment* International Programme on the Elimination of Child Labour (Thailand-Lao PDR, Thailand-Myanmar border areas) ILO Geneva

Ministry of Labour and Social Welfare / Committee for Planning and Cooperation / ILO, 2003, *Labour Migration Survey in Khammouan, Savannakhet and Champasack 2003*

Norwegian Church Aid, 2002, Xuan Sivoraphan, Bodil Tumyr, Minavanh Pholsena: *Migrant labours in Xayphouthong District, Savannakhet Province* Lao PDR

US State Department, 2004, *International Narcotics Control Strategy Report 2003*

UNICEF (n.d.) *Report on the survey and the situation regarding the trafficking of children in the Lao PDR*

UNICEF (n.d.) *How I Got Here: Commercial Sexual Exploitation of Children in Lao PDR*. Ministry of Labour and Social Welfare, UNICEF, Vientiane, Lao PDR.

UN Inter-Agency Project to combat trafficking in women and children in the Mekong sub-region 2002, by Oren Ginzburg *Building Projects on Assumptions, trip report from Laos*

UNODC, 2002, *Laos Opium Survey2002*

UNODC, 2003, *Laos Opium Survey2003*



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ANALYSIS AND NAM THEUN 2 CONTRIBUTIONS



Annex 8: Ethnic Minorities

Prepared by: Stephen Sparkes

November 2004

TABLE OF CONTENTS

1	ETHNIC MINORITIES STATUS	1
1.1	Ethnic Identity	1
1.1.1	Definitions of Ethnicity and Ethnic Identity.....	1
1.1.2	ADB and WB Guidelines and Safeguard Policies	1
1.2	Ethnic Groups in Lao PDR	2
1.2.1	Definitions and Categories	2
1.2.2	Historical Relations and 'Indigenous Peoples'	5
1.2.3	Changing Ethnic Context	6
1.2.4	Main Trends: Assimilation and Integration	6
1.2.5	Degrees of Vulnerability	6
1.3	Ethnic Groups in Vietnam	7
1.3.1	Definitions and Categories	7
1.3.2	Historical Relations	8
2	ETHNIC MINORITIES IN NT2 PROJECT AND ADJACENT AREAS	9
2.1	Lowland Lao and Related Groups	9
2.1.1	Tai-Lao.....	9
2.1.2	Phou Thay.....	10
2.1.3	Tai Subgroups.....	10
2.1.4	Possible Hybrid Groups: Tai Bo and Lao Kaleung	10
2.2	Minority Groups	11
2.2.1	Brou and other Mon-Khmer Groups	11
2.2.2	Vietic Groups	11
2.2.3	The Hmong	12
2.3	Minority Groups in Adjacent Districts of Vietnam.....	15
2.3.1	Baseline Information on Adjacent Districts	15
2.3.2	Chút (Vietic)	15
2.3.3	Bru-Vân Kiêu (Brou).....	15
3	INTEGRATION AND ASSIMILATION TRENDS.....	16
3.1	Overview of Trends	16
3.1.1	Economic and Political Integration	16
3.1.2	Cultural Assimilation.....	16
3.2	Livelihood Systems	17
3.2.1	Sedentary Lifestyles and Resettlement.....	17
3.2.2	Limitations on Swidden	17
3.2.3	Exhaustion of Natural Products.....	17
3.3	Material Culture	18
3.3.1	House Designs.....	18
3.3.2	Clothing Styles	18
3.3.3	Other Material Changes	19
3.4	Language	19
3.4.1	Present Language Status and Usage	19
3.4.2	Trends in Minority Language Usage	20
3.5	Religious Practices.....	21
3.5.1	Buddhism and Traditional Cultural Beliefs.....	21
3.5.2	Changing Religious Practices	21
3.6	Migration, Relocation and Urbanisation	21
3.6.1	Natural Population Increase	21
3.6.2	Migration to Roads	22
3.6.3	In-migration	23
3.7	Socio-Economic Development	23
3.7.1	Economic Development	23
3.7.2	Health Services	24
3.7.3	Education Services	24

3.8	Political Integration.....	25
3.8.1	Replacement of Traditional Structures.....	25
3.8.2	Parallel Power Structures.....	25
4	CONCLUSIONS AND RECOMMENDATIONS.....	26
4.1	Ethnic Minorities and Global Trends.....	26
4.1.1	Nation State and Multicultural Diversity.....	26
4.1.2	The Cost of Ethnic Diversity.....	26
4.2	Scenarios for Nakai Plateau.....	27
4.2.1	5-year Scenario.....	27
4.2.2	20-Year Scenario.....	27
4.2.3	Recommendations.....	27
4.3	Nakai-Nam Theun NBCA.....	28
4.3.1	5-year Scenario.....	28
4.3.2	20-Year Scenario.....	28
4.3.3	Recommendations.....	28
4.4	Scenarios for Xe Bangfai and Surrounding Districts.....	29
4.4.1	5-year Scenario.....	29
4.4.2	20-Year Scenario.....	30
4.4.3	Recommendations.....	30
4.5	Scenarios for Nam Theun, Nam Kading, Nam Hinboun and Surrounding Districts.....	30
4.5.1	5-year Scenario.....	30
4.5.2	20-Year Scenario.....	31
4.5.3	Recommendations.....	31
4.6	Scenarios for Vietnamese Provinces.....	31

LIST OF TABLES

Table 1: Ethnic Groups, according the to the Institute for Ethnic Studies, Vientiane, 2000.....	4
Table 2: Historical Status.....	5
Table 3: House Design Changes.....	18
Table 4: Language Trends for Ethnic Minorities.....	20
Table 5: Village Size 1995 and 2003/04.....	23

LIST OF MAPS

Map 1: Ethnolinguistic Groups in Lao PDR.....	3
Map 2: Ethnic Minorities of the Nakai Plateau and Surrounding Areas.....	13
Map 3: Ethnic Minorities of the Xe Bangfai and Downstream Areas of the NT2 Project.....	14

1 ETHNIC MINORITIES STATUS

1.1 Ethnic Identity

1.1.1 *Definitions of Ethnicity and Ethnic Identity*

Before discussing ethnicity and the status of the various ethnic minorities and groups of the Nam Theun 2 project and the surrounding areas, it is necessary to establish a workable definition. In anthropology, *ethnicity* is identification of a category or group according to unique or different qualities, broadly speaking, linguistic, socio-cultural or racial. The features of labelling and contrasts between groups, however, are not fixed but rather subject to constant reinterpretation. Boundaries seldom prohibit individuals from moving back and forth between groups, as is in cases of intermarriage.

Ethnicity is manifested in objective and subjective manners, that is as categorisation by others ('etic') and as self-identification or shared meanings within the group ('emic'). Hence, a discussion of ethnicity identity has two sides: classification (imposed by anthropologists, governments and others from outside) and identity (how members of a group see themselves). These two sides are not always compatible, especially in times of rapid or uneven socio-cultural and economic change when categories are negotiated, meanings challenged and identities merged. The situation in many parts of central Lao PDR can be described as 'fluid' in terms of ethnicity and ethnic identity.

1.1.2 *ADB and WB Guidelines and Safeguard Policies*

Both the ADB (ADB Policy and Operations Manual 2003) and WB (OD 4.20 1991) have guidelines regarding Indigenous Peoples and Ethnic Minorities (the latter term shall be used from now on – see Section 1.2 below). These guidelines acknowledge that indigenous peoples and ethnic minorities can be regarded as vulnerable segments of society, often with lower standards of living than dominant cultural group and unable to participate in the social, cultural and political development on a par with other groups, despite legislation and recognition. The approach advocated is for culturally sensitive and participatory planning and implementation so that these groups may benefit from projects and development in a manner that enhances their unique socio-economic and cultural status.

According to ADB and WB, Ethnic Minorities have the following key characteristics:

- Self-identification and identification by others as being part of a distinct cultural group (emic and etic)
- Language or 'linguistic identity' different from dominant cultural group
- Social, economic and political traditions and institutions different from dominant culture
- Traditional economic systems – subsistence production
- Attachment to traditional territory and its natural resources

Applying these characteristics to the ‘fluid’ ethnic situation in Lao PDR is the challenge facing planners. An assessment of development and change in terms of five and 20-year scenarios is particularly difficult since there are few long-term studies of ethnic change in the country or the region.

1.2 Ethnic Groups in Lao PDR

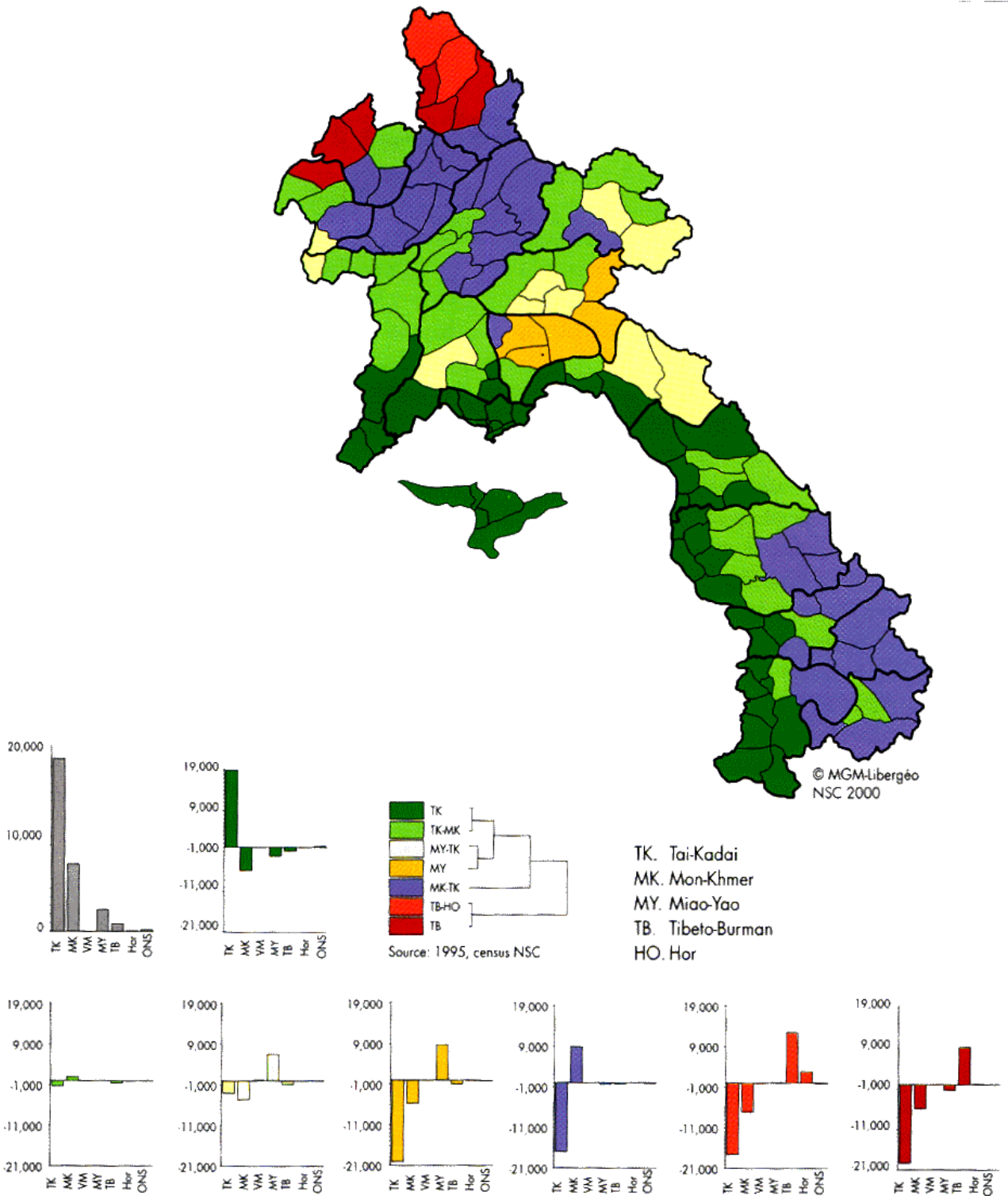
1.2.1 Definitions and Categories

Official terminology for the classification of ethnic groups according to the 1991 Lao constitution and a review by the National Edification Committee (August 2000) consists of a two-tiered system with 49 main ethnic groups and over 100 sub-groups. There are four main ethno-linguistic categories in the country: Lao-Tai, Mon-Khmer, Sino-Tibetan and Hmong-lumien groups. See Table 1-1 on the next page.

In addition, there are three terms most commonly used by the government and by the population itself when describing the classification of ethnic groups in practice:

- Lowland Lao (*Lao Loum*), groups living in the lowland regions of the country that for the most part cultivate paddy, practice Buddhism and are integrated into the national economy. These correspond to the Lao-Tai group and represent approximately 65% of the population.
- ‘Slope Dwellers’ (*Lao Theung*), groups dominating the middle hills that for the most part practice swidden agriculture, are reliant on forest products and to some extent are isolated from the dominant lowland culture. Many groups, however, exhibit varying degrees of assimilation and adaptation to Tai-Lao culture. These groups are the original inhabitants of SE Asia and consist of the Austro-Asiatic or Mon-Khmer ethnic groups (approximately 25% of the population).
- ‘Highland Lao’ (*Lao Suung*), groups dwelling in the highland areas practicing swidden agriculture and include the Sino-Tibetan and Hmong-lumien ethnic groups. Many of these groups are relatively recent arrivals from Southern China and Vietnam and form about 10% of the population. There are also examples of these groups settling in lowland areas.

Map 1: Ethnolinguistic Groups in Lao PDR



Source: Center for Southeast Asian Studies, Northern Illinois University
(http://www.seasite.niu.edu/lao/Lao_maps/language_family.htm)

Table 1: Ethnic Groups, according to the Institute for Ethnic Studies, Vientiane, 2000

Lao-Tai Ethno-linguistic Group – 8 ethnic groups	
1	Lao Phouane Kaleung Bo Yooy Nyo
2	Phou Tai
3	Tai Tai Dam Tai Deng Tai Khao Tai Meuy
4	Lue Khun
5	Nyuan Kalom Nyiao
6	Yang
7	Sek
8	Tai Neua

30	Cheng
31	Sadang Kayong Sadang Duan
32	Suey
33	Gnaheun
34	Lavi
35	Pako Kado Kanai
36	Khmer
37	Toum Liha Thai Cham Thai Pong
38	Nguan
39	Muang
40	Kri Maleng Labri

Mon-Khmer Ethno-linguistic Group: 30 ethnic groups	
9	Khmu Kasak Ou Lu Gnuan Khrong Kheun Me Chuang Rok
10	Pray (Pray)
11	Sing Mul (Sing Mul)
12	Phong Piat Lan Fen Chapuang
13	Then
14	Eudou
15	Bit
16	Lamet
17	Samtao Doi
18	Katang Phakeo
19	Makong Trui Phoua Maroih Trong
20	Tri
21	Yuru Kong Yinr
24	Yeh
25	Brao Kavet Halang
26	Katu Triou Dakang
27	Harak
28	Oi Sapuan Sok In Thi
29	Krieng Chatong

Sino-Tibetan Ethno-linguistic Group – 8 ethnic groups	
41	Akha Oma Kheu Muteun Chicho Puli Pana Fe Mukui Luma Eupa Chipia Muchi Ya eu Kongsat
42	Singsri Phou Gnot Tapay Ban Tang Cha Ho Lao Seng Phay Lao Pan Phong Kou Phong Set
43	Lahu Lahu Dam Lahu Khao Kui
44	Sila
45	Hani
46	Lolo
47	Ho

Hmong Lumien Ethno-linguistic Group	
48	Hmong Hmong Khao Hmong Lai Hmong Dam
49	lumien Lanten Yao Phomdeng Yao Khao

Koh

1.2.2 Historical Relations and ‘Indigenous Peoples’

The term ‘indigenous peoples’ is not used in Lao PDR, as is also the case in Vietnam and China. Rather the term ‘ethnic groups’ that corresponds to the Lao term, *xon phao*¹ is used to describe all ethnic groups in the country. This ignores to some extent the historical relations between groups and the fact that the earlier or original inhabitants of the region were members of the Mon-Khmer groups; all other ethnic groups arriving later.

Table 2: Historical Status

Ethno-linguistic Group	Historical Status	Comments
Mon-Khmer	‘Indigenous’ to most of what is now Lao PDR	Various levels of social and technological development, ranging from small groups of hunter-gatherers (Vietic) to ‘tribal based societies’ (Makong) to civilisations (Khmer).
Tai	Migrations from southern China and northern Vietnam from 11-13 centuries onwards	Dominant group in lowland areas through the establishing of <i>muang</i> or ‘chiefdoms’, some of which later developed into kingdoms (eg Luang Prabang). Some Tai remain as the ‘tribal’ level of social organisation in upland areas.
Hmong-Mien	Arrived from China via Vietnam from the 19 th Century onwards	Predominantly primary swidden cultivators inhabiting highland areas but recently some groups resettled in lowlands. Clan structure.
Sino-Tibetan	Recent migrations, mostly during the 20 th Century	Swidden cultivators in the highlands of the northernmost provinces in the country. Tribal or clan structures.

Hence, the term ‘indigenous’ can mostly easily be applied to the Vietic groups who most likely inhabited large areas of Bolikhamxai and Khammouane Provinces before the arrival of the other ethnic groups, including other Mon-Khmer groups. All other groups have moved into parts of the project area recently displacing and absorbing the Vietic populations at different times, even creating new ethnic categories such as the Kaleung and Bo (former Brou and Vietic groups that are now classed as Tai). It is important to note that this process has marginalised Vietic groups and resulted in a gradual loss of land and natural resources. The hunter-gather lifestyle requires relatively large areas for ecological sustainability and increased population and exploitation has resulted in many Vietic groups opting for a sedentary livelihood over the past three decades.

The Lao government’s policy regarding ethnic minorities is linked to efforts at poverty alleviation and the elimination of unsustainable shifting cultivation. This is manifested in a number of ways, one of which is relocation of more isolated groups in the highlands to lowland areas near existing infrastructure and services. The ethnic groups on the Nakai Plateau have not been affected by such a policy except for attempts at collectivization in the late 1970s, which were ultimately not successful. There are presently no plans for relocation of these groups to lowland areas and no Special Economic Zones designated in the pro-

¹ The Lao term, *xon phao*, is derived from two words: *xon*, meaning ‘together’ and *phao*, meaning ‘clan’, ‘family’, ‘line’ or even ‘race’. Hence the usual translation of ‘ethnic group’ in official parlance. The expression implies a common sense of identity based on kin relations, marriage and racial background.

ject area. However, there are ongoing resettlement programme along transportation corridors in the surrounding districts.

1.2.3 *Changing Ethnic Context*

The situation in terms of ethnic identity is fluid in the NT2 project area and surrounding areas. This is due to the changing socio-economic and cultural context. This is not a recent phenomenon but the process seems to be accelerating due to a number of factors:

- Government programmes for relocation and village consolidation of smaller units in order to provide services and infrastructure (new administrative units and focal development zones)
- Increased urbanisation and migration to roads and cities from the surrounding countryside
- Increased mobility of populations and increased interaction between ethnic groups, including intermarriage
- Increased self-identification with the mainstream Lao culture which is seen as 'progressive' and modern in comparison to traditional socio-economic and cultural systems

1.2.4 *Main Trends: Assimilation and Integration*

The terms assimilation and integration are both used to describe a process of social and cultural change. There is some overlap when using these terms. Assimilation often refers to policies imposed from above that could contribute to the loss of ethnic diversity, such as one language education, promotion of rapid economic change, increased access to services, markets and jobs, resettlement and relocation programmes and livelihood policies (halting the practice of swidden agricultural in upland areas). It is not always the intension of governments to assimilate ethnic minority groups but policies and programmes that promote modernisation often do not take into consideration cultural differences and vulnerability to change.

Integration occurs when minority groups identify with and aspire to aspects of the majority culture and changing socio-economic conditions, such as adapting language, religion, behavioural patterns and material culture. There is a notion of 'willingness' in the term integration, of the minority culture 'choosing' to some extent from the merging opportunities for development.

The situation in Lao PDR is complex and a mix of assimilation and integration in most part of the country and for most groups. Nearly all groups aspire to improved living conditions and many seek a better future for their children by having them learn the Lao language, adapting Buddhist practices and integrating themselves into the mainstream economic and political systems.

1.2.5 *Degrees of Vulnerability*

When discussing impacts on ethnic groups in the context of hydropower development or the development of any large infrastructure project, it is necessary to distinguish between groups in terms of vulnerability. In the context of Lao PDR,

there are significant differences between ethnic groups. One should consider the following factors:

- Size and the inner cohesion of ethnic groups in terms of social structures and social organisation – the smaller the group and the more flexible the social structure ('small-scale societies'), the more vulnerable to change and assimilation
- Location of the ethnic group both in terms of isolation from other groups and in terms of surrounding groups – groups that are spread out over large areas and separated (fragmented) by other groups are more vulnerable
- Reliance on natural resources is another aspect to consider since groups that utilise forest products (NTFPs) require large areas in which to sustain traditional livelihood patterns of hunting and gathering. These areas are being infringed upon by other groups that turn forests into agricultural areas, reducing these territories and the ability of groups to harvest in a sustainable manner.
- Degree of integration into the mainstream economy determines the degree of vulnerability to rapid socio-economic change that can be a result in market demands for natural products and an increase in the demand for manufactured goods among minority groups.
- Differences in social and cultural systems are also factors since groups with very different social systems and belief systems, such as small social units (household or tribal organisations) and animist beliefs, can be classed as 'underdeveloped' by groups organised with the nation state and adhering to the Buddhist faith.
- Representation in the political system will ensure that local interests are taken into consideration in relation to government policies at the local, district and national levels. Lack of representation or limited participation in politics may be construed as a sign of vulnerability.

The following table illustrates the degree of vulnerability and incidence of poverty for the different minority groups within the project direct impact area and surrounding areas.

1.3 Ethnic Groups in Vietnam

1.3.1 Definitions and Categories

The issue of ethnic minorities is politically sensitive and complex in Vietnam. As with Lao PDR, there is an official categorisation (54 ethnic groups recognised) and census (approximately 14% of the population in 1999). Most of these groups are located along border areas, Tai groups along the Chinese border and parts of northern Lao PDR and Mon-Khmer groups along the rest of the border with Lao PDR and Cambodia.

The classification of groups into *dan toc theiu so* or nationalities is based on a common language, common cultural traits and self-identification. There are no ambiguities of classification, ignoring the fact that there has been considerable inter-marriage and merging identities.

1.3.2 *Historical Relations*

The main theme of the historical relations between the Kinh or Vietnamese majority and minorities is one of the dominant group's increased presence in minority areas in terms of direct political control (formerly semi-autonomous areas), education (national curriculum), national institutions and policy, economic development and exploitation of natural resources. There has been considerable resettlement of the Vietnamese majority into traditional areas, as is the case for the provinces bordering the Nakai-Nam Theun NBCA (in 1943, ethnic minorities represented about 95% of the population in the Central Highland but in 1975 these groups were only 33%: Rambo 2003:129).

2 ETHNIC MINORITIES IN NT2 PROJECT AND ADJACENT AREAS

There is a dynamic situation that makes it difficult for scholars and authorities to agree up the actual number of ethnic groups, and a number of the groups in the project area are not listed on official lists as shall be explained in the following chapter. Ethnic minorities, that is non-Tai-Lao groups make up approximately 40.2% of the three provinces in the project area.

: Ethnic Minorities in the Three Affected Provinces

Province	1995 Census Data	1997 Population Estimates	
		Total	% Ethnic Minorities
Bolikhamxay	163,589	171,201	34,240 (20.0%)
Khammaoune	273,779	288,600	134,500 (46.6%)
Savannekhet	671,581	711,500	302,400 (42.5%)
3 Provinces	1,108,949	1,171,301	471,140 (40.2%)

Sources: 1995 National Census, Lao PDR

The main groups in the region consist of:

- The dominant Lao ethnic group and related Tai-Lao groups
- Mon-Khmer groups
- Vietic groups (previously hunter-gatherers)
- Hmong

2.1 Lowland Lao and Related Groups

2.1.1 Tai-Lao

The dominant and majority ethnic group in Lao PDR is the Lao or Tai-Lao, making up a little over half of the population of the country and about one third of the population in and around the NT2 Project area, mostly in urban areas and in the lowlands, such as along the Xe Bangfai. This grouping consists of a number of local sub-groups such as Nyo, Yooy and other local groups. The Lao are usually an important group in all large villages with market centres and towns in lowland areas of Khammouane and Savannakhet Provinces but in particular along the Mekong River and NR13. A number of Tai-Lao have recently settled in towns or new villages on the Nakai Plateau.

All Lao groups are characterised by Buddhism and paddy production in lowland areas of the country. The Lao exhibit matrilineal tendencies but inheritance, responsibility for parents in old age and the location of children's houses depend on pragmatic considerations of wealth, skills and relationships. Lao villages in the lowlands are integrated to a large extent into the mainstream economy since they are usually located close to roads and markets and have access to services, and

are often characterised by the use of irrigation systems. The Lao dominate the service industries, education and government services throughout the country.

Various *Lao Theung* groups that have adapted Lao Loum identity over the centuries and become or are rapidly becoming fully assimilated into *Lao Loum* or lowland Lao culture. They exhibit all the characteristics of other Lao groups but there are certain aspects of earlier cultural practices that linger.

2.1.2 *Phou Thay*

The Phou Thay are also classified as *Lao Loum* and belong to the Tai ethnolinguistic family. Their language and culture are similar to the Lao, and they share similar beliefs (Buddhism) and livelihood systems, that is paddy cultivation in lowland areas. The Phou Thay are concentrated along the Xe Bang Fai and Xe Noy rivers in Savannakhet and Khammouane provinces, occupying lowland areas east of the Lao for centuries, possibly arriving in the area at the same time or before the Lao. They represent a little less than one third of the population along the Xe Bangfai.

Due to cultural similarities and considerable intermarriage with the Lao, Phou Thay culture appears to be merging with Lao culture or at least shares many similar traits. Most Phou Thay are fluent in Lao and are integrated into the mainstream culture and economic system.

2.1.3 *Tai Subgroups*

The Upland Tai ethnic groups have been migrating southwards from their original homelands in northwest Vietnam over the past two centuries. The Tai are now moving into the northern areas of the Nakai Plateau and Nakai-Nam Theun NBCA from densely populated area around Ban Lak Sao, in search of land and sources of income. These Tai practice paddy cultivation (Lak Sao area) and swidden (along the Nam Theun). The Tai groups are patrilineal and animist with only minor Buddhist influences, sharing many of the same cultural traits as other Tai in northern Lao PDR and Vietnam. Common sub-groups in the region include the Tai Men, Moey, Kwan and Pao. Differences between the different Tai groups are more along the lines of clan differences rather than ethnic differences.

2.1.4 *Possible Hybrid Groups: Tai Bo and Lao Kaleung*

The Tai Bo are an example of the ongoing assimilation and adaptation. The Bo are likely to have been Vietic groups that have lost their indigenous languages and adapted a sedentary lifestyle with swidden cultivation like the other inhabitants in the area. Intermarriage between the Tai Bo and other groups is quite common.

The Tai Bo consider themselves as the 'original' inhabitants of the Nakai Plateau but historical evidence indicates that many groups have inhabited or passed through this region over the past 300 years. The word 'Bo' (*bau*) means mine or in this case the salt mines that were developed during the French colonial period in areas to the west of the Nakai Plateau. The groups living there were probably associated with these mines or used them and then later used this designation as a marker of cultural and ethnic identity. The prefix 'Tai' (*tai*) was probably added later to legitimize their status as an authentic ethnic group similar to Tai Men, Tai Moey, Tai Dam, etc. Some Bo also claimed that they were 'Tai Nakai', meaning Tai from the Nakai region.

The Tai Bo are an example of a dynamic and changing ethnic identity and of assimilation of the dominant Lao culture. This example illustrates the flexibility and adaptability of ethnic identity in the region where movement, assimilation and cultural borrowing are common. A comparison of Tai Bo with other Lao and Tai languages and dialects at the end of this chapter indicates a similarity with the closest Tai languages that surround the Plateau, Phou Thay, Tai Yooy and Tai Nyo.

The situation with the Lao Kaleung may be similar to the Bo in some ways. The Lao Kaleung are officially classified as *Lao Loum*, however the term Kaleung seems to indicate that they could have been a *Lao Theung* group that has been assimilated or adapted to Lao or Tai language, culture and customs. It is likely that the Lao Kaleung could have originally been Brou groups since they have a 'special relationship' with the Brou in that neither is to break the cultural taboos of the other. The Lao Kaleung language resembles Phou Thay and Tai Yooy in accent. The Lao Kaleung are found in largest concentrations around the town of Mahaxai.

2.2 Minority Groups

2.2.1 *Brou and other Mon-Khmer Groups*

The Brou (and Sub-groups, such as the Chalui, Tri, Katang, etc.) represent a homogenous ethno-linguistic group ranging from the Vietnamese border to the lowland areas below the Nakai Plateau in Gnommalat and Boualapha Districts, where they are one of the dominant groups. The Brou are recent migrants to the Nakai Plateau and in the Nakai-Nam Theun NBCA where their livelihood systems differ from their lowland cousins. This group has been very adaptive in that their livelihoods range from mixed hunter-gatherers/swidden farmers in the Nakai-Nam Theun NBCA through to wet rice cultivators in the lowlands. The Brou are patrilineal and patrilocal and practice exogamy.

2.2.2 *Vietic Groups*

The Vietic groups are found on the Nakai Plateau and in the NT2 Watershed. On the Nakai Plateau they have undergone a good deal of assimilation in contrast to the small pockets in the Nakai-Nam Theun NBCA where most live in relatively isolated areas where pressures to adapt to other more technologically advanced and larger groups have been less pronounced. The Vietic can be considered as the 'original' inhabitants of the area since all other groups have entered at a later date. It appears that the Vietic groups have been displaced by others with agricultural practices, such as the Brou and Tai.

Originally, the Vietic groups were hunter-gatherers and were spread thinly over a large area since low population density is necessary with this type of livelihood. They now comprise approximately about 12% of the villagers on the Nakai Plateau and 25% of the population in various locations in the Nakai-Nam Theun NBCA. There are numerous sub-groups, including the Ahoé, Salang, Phong, To'e and Melang.

Most of these are now sedentary farmers and many have inter-married with Brou and Tai and adapted various forms and degrees of sedentary lifestyles. There is evidence to suggest that many Vietic groups are being assimilated into other groups with more advanced technology. However, they are still the least integrated into the national economy and have traditionally relied heavily on wildlife, fishing and collection of forest products for trade.

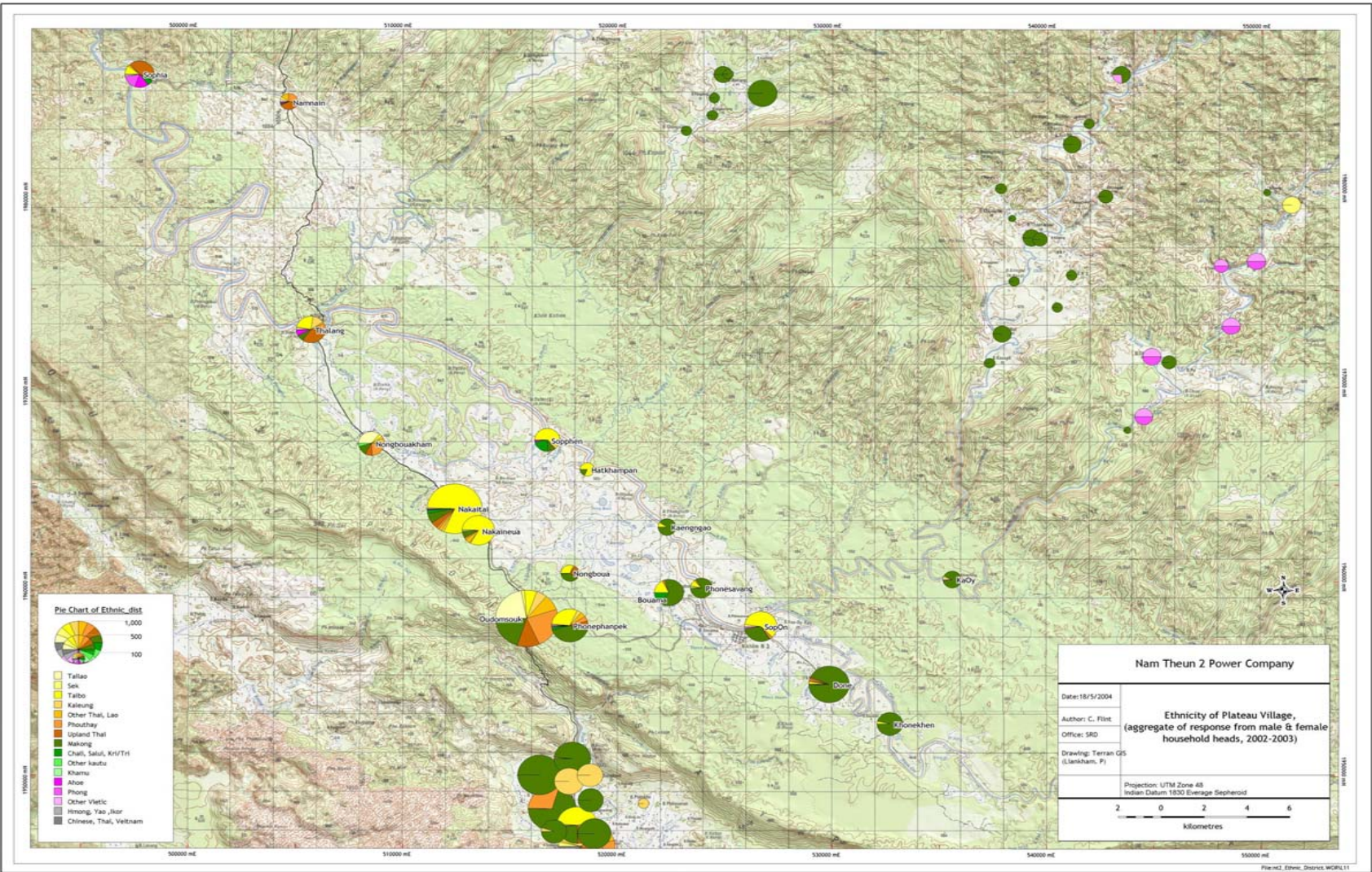
Collectively, the Lao refer to the Vietic groups as *kha*, meaning 'slave', a term used for many Austro-Asiatic groups, indicating that these were hunter-gatherers and without the 'signs of civilization' (Buddhism and rice cultivation, according to the lowland Lao) until quite recently. The designation of *Lao Theung* by the Lao Government distinguishes them from lowlanders.

2.2.3 *The Hmong*

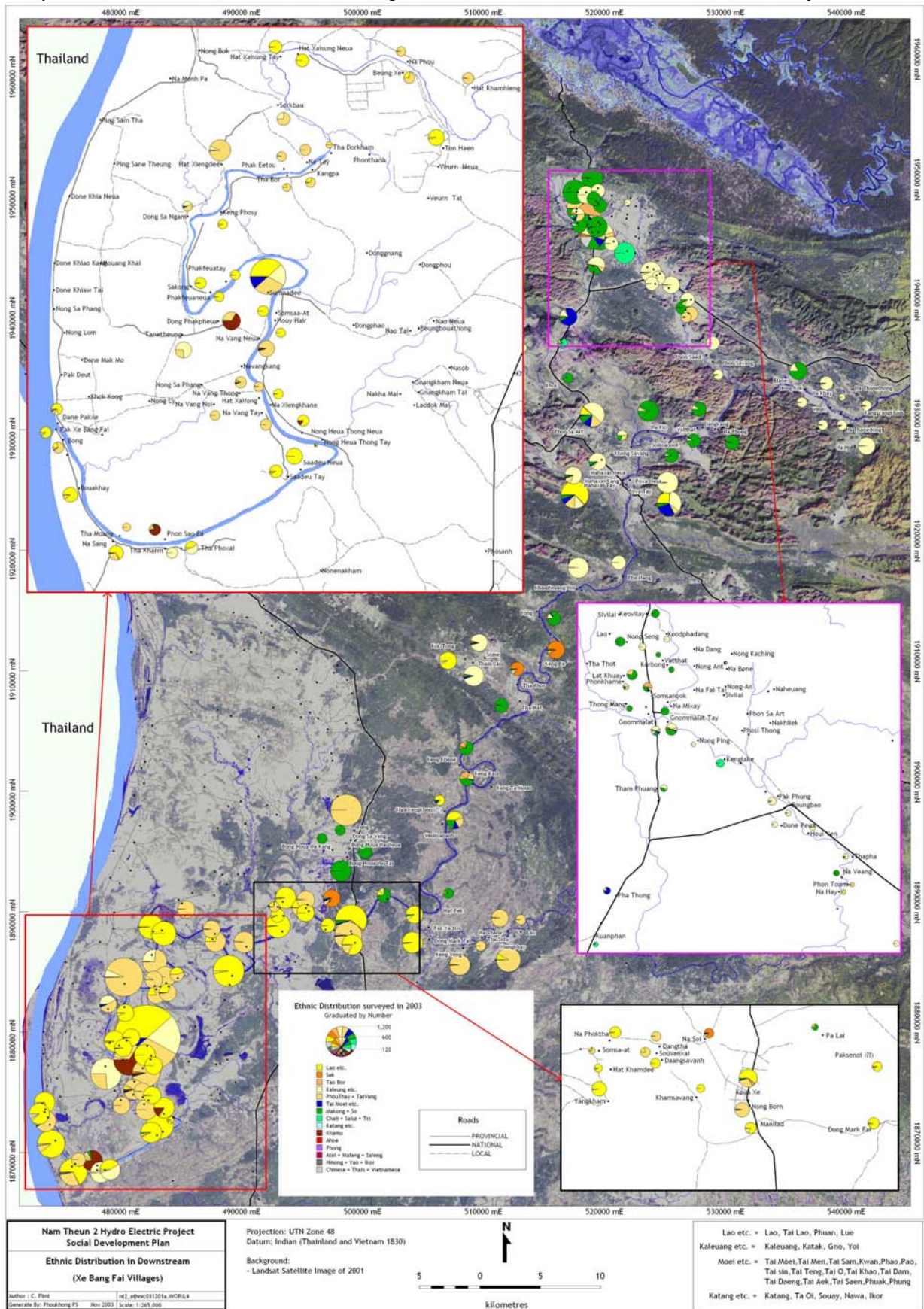
There are Hmong groups present to the west of the NT2 Watershed and in parts of the catchment of the Theun Hinboun Project, along the Nam Gnung and tributaries of the Nam Theun. These Hmong communities are among the southernmost in Lao PDR and appear to be expanding southward further into the NBCA, practising primary swidden cultivation for centuries on their long journey from central China to Southeast Asia.

The Hmong are highly organised into clans (*sing*), have relatively high level of technology in the form of metal tools, firearms and housing and their own distinct language, customs and religion that is primarily based on Chinese Taoism. There are almost no cases of inter-marriage with other groups. The Hmong have adapted well to paddy cultivation when given the opportunity to do so but apart from a few Hmong resettlement villages where paddy has been developed and technical assistance forthcoming, most survive on swidden and hunting and gathering. The Hmong pose a threat to the biodiversity of the NBCAs and to the small vulnerable minority groups (Vietic) whom they have as neighbours.

Map 2: Ethnic Minorities of the Nakai Plateau and Surrounding Areas



Map 3: Ethnic Minorities of the Xe Bangfai and Downstream Areas of the NT2 Project



2.3 Minority Groups in Adjacent Districts of Vietnam

2.3.1 *Baseline Information on Adjacent Districts*

The ethnic composition of Ha Tinh and Quang Binh Provinces in Vietnam is overwhelmingly Kinh or dominant Vietnamese group. Specific or disaggregated information on ethnic minorities and development for these provinces is difficult to obtain. The facts presented are based on official reports and anthropological studies as well as material from various donor projects.

However, based on national surveys and studies (UNDP 2002) there is a widening poverty gap between the minorities and the majority Vietnamese. This is despite modest gains and efforts to focus development on minorities through government and donor projects. Development challenges include isolation and remoteness, reduced access to good land and natural resources, low access to credit and productive assets, limited quality of social services and limited participation in government structures and public life. In addition, the process of resettling of small groups like the Chút has probably also made social development very challenging.

2.3.2 *Chút (Vietic)*

The official category of Chút corresponds to the ethno-linguistic category of Vietic and consists of five sub-groups: Sach, May, Ruc, Arem and Ma Lieng. Other names are Tu Vang, Pa Leng, Cha Cui and Tac Cui. The total population of these groups is around 3000 individuals in 2000, located in Minh Hoa, Tuyen Hoa and Bo Trach Districts in Quang Binh Province and in Huong Khe District in Ha Tinh Province. As with small minority groups in Lao PDR, there is pressure to integrate and assimilate into the mainstream cultural, social, political and economic systems, as outlined in the above section. In fact, there are many parallels between the situation for ethnic groups in Vietnam and Lao PDR in terms of an ongoing transition from traditional hunting and gathering livelihood in forest areas to settled agriculture. The Sach have been integrated and reside in the lowlands while the Lieng still reside exclusively in the highlands and are less integrated.

2.3.3 *Bru-Vân Kiều (Brou)*

The Bru-Vân Kieu (including sub-groups of Tri, Khua and Ma Coong), known in Lao PDR as the Brou or Makong, is a large ethnic minority, with about 40,000 Brou in Vietnam in areas bordering the Nam Theun 2 Watershed (Dang *et al.* 1993). They are found all along the border of Quang Binh Province and further south. The Brou are primarily swidden cultivators but more and more groups appear to be converting to paddy cultivation as they come into contact with Vietnamese culture and technology. As with the Brou in Lao PDR, there are varying degrees of technological development and livelihood systems. The Brou language and cultural practices are still very much a part of the local culture. It is very difficult to assess this in detail, however, without a more recent anthropological survey. Official statistics and descriptions do not allow for any meaningful analysis of the situation at present.

3 INTEGRATION AND ASSIMILATION TRENDS

General and with project impacts and mitigation

3.1 Overview of Trends

3.1.1 Economic and Political Integration

There are some clear overall economic trends in the project area and in the surrounding areas that affect all ethnic groups:

- Integration into the national and regional economies
- Change from subsistence production systems to market economy (surpluses)
- Change of orientation from barter to cash interactions
- More intensification of livelihood systems
- Change from hunting-gathering/swidden to rainfed and irrigated paddy
- Replacement of traditional structures with formal political structures

Many of these economic and political changes are due to government policies and programmes, such as the reduction of swidden cultivation, while others are a complex mix of local and regional developments.

3.1.2 Cultural Assimilation

The rich cultural diversity in terms of languages, livelihood systems and culture of the NT Project area and adjacent areas has been undergoing a process of cultural assimilation for some time. It is likely that the NT2 Project will hasten a number of aspects. The main aspects are:

- Replacement of ethnic languages with national languages (Lao and Vietnamese)
- Increased social and economic interaction between ethnic groups and increased intermarriage
- World religions – Buddhism and in some cases Christianity – are replacing traditional religious practices
- Many ethnic groups are identifying themselves with the values systems, language and customs of majority groups

3.2 Livelihood Systems

3.2.1 *Sedentary Lifestyles and Resettlement*

The last half-century has marked the end of the traditional hunter-gather existence in Lao PDR. Those last groups of Vietic nomadic hunters and gathering in the NT2 Project area were forcibly resettled in a number of government programmes in the late 1970s-1990s, bringing to an end an ancient livelihood form. There are still a number of small Vietic groups highly dependent on hunting and gathering in the forests of the NBCA and buffer areas but all are now engaged to some extent in agriculture.

These resettlement programmes have had poor results since there has not been the understanding of traditional livelihoods, belief systems and social organisation, nor agricultural extension support and follow-up. A few Vietic groups have developed their own systems by copying Brou, Tai and Sek agricultural production. The SEMFOP-1 proposes an evolution of livelihood systems and reveals that all ethnic groups practice a range of production systems and that there is considerable flexibility. However, for the former hunter-gatherers considerable support and careful monitoring is required.

3.2.2 *Limitations on Swidden*

Government policy is to reduce and eventually eliminate swidden or slash and burn cultivation as part of their forestry and agricultural development strategy. Most ethnic minorities are or will be affected by this policy since swidden is the most common means of obtaining rice, the staple crop of all groups.

There are many areas where swidden production is unsustainable (along the Nam Theun along the Theun Hinboun Project headpond and on the Nakai Plateau) or expanding (buffer areas of NBCAs and inside the Nakai-Nam Theun NBCA) due to population increase and in-migration due to infrastructure development.

Alternatives to present swidden production are complex and require considerable support and funding if they are going to be sustainable in the long-term. Initiatives along the Nam Theun as part of a mitigation strategy for the Theun Hinboun Project combine a number of agricultural improvements, including terracing, livestock production and other income-generating schemes. The income restoration strategy for the Nakai Plateau resettlers consists of forestry, fisheries, irrigated agricultural production and wages as options.

3.2.3 *Exhaustion of Natural Products*

Another aspect of livelihoods that is especially important for ethnic minorities is the harvesting of Non-Timber Forest Products. Since many minorities are more dependent on hunting and gathering of NTFPs, they are more vulnerable to the present modernisation of the country, in particular the integration of outlying areas into the market economy and population increase.

There are several indications that the present rate of harvesting these products is not sustainable. The availability of NTFPs on the Nakai Plateau, for example, has decreased dramatically over the last ten years. This is due to a combination of factors, including increase in demand, improved access to areas and the entry of communities into the mainstream economy. Local communities on the Nakai Plateau, along NR9 and in Khamkeut often have to fulfil government quotas and

agree in advance, often in exchange for rice, on an amount to be supplied to businessmen from outside the region. This, needless to say, is not a sustainable approach to harvesting NTFPs.

3.3 Material Culture

3.3.1 House Designs

There is a considerable range of house designs, both in terms of ethnic differences and general size and conditions. The general trend is for adaptation of lowland inspired architecture. Vietic houses have changed from temporary huts constructed of bamboo are becoming more permanent in the NBCA, adapting many characteristics of neighbouring groups. Brou houses are starting to resemble Lao and Phou Thay house structures both in the lowland areas and on the Nakai Plateau.

Some of the main characteristics that are changing rapidly are listed in the following table:

Table 3: House Design Changes

Characteristic	Traditional Style	Modern Style
Terraces	Enclosed or absent	Larger, open areas
Construction materials	Bamboo, rattan, wooden tiles and thatch	Wooden planks, ceramic tiles, concrete and
Doors and windows	Small double doors (kinship rules) and small windows	Larger doors and windows
Ladders and steps	Two sets of small bamboo ladders	Larger, more permanent ladders or concrete steps
Stilts	Construction on shorter poles or on the ground (Hmong)	Houses on raised poles – at least 1.5 m high
Storage areas	Areas under house for storage and work (open)	Enclosed areas for tractors and shops (urban areas)
Kitchen areas	Separate, small structure beside the house or on the same platform	Kitchen under the house or as a room inside the house (urban areas)

3.3.2 Clothing Styles

Clothing styles are becoming very similar throughout the area. Traditional clothing styles that once distinguished some ethnic groups are rare in the case of most groups. Most groups now buy their clothes from local markets that are produced locally or are cheap textiles from Thailand, China and Vietnam.

Some notable exceptions are the Hmong who still wear their traditional black attire and whose women still produce traditional embroidery patterns to adorn their skirts and jackets. There are also examples of Vietic groups (Liha) and some variation in Tai-Lao majority groups that retain distinctive clothing. However, most of the minorities no longer make traditional clothes and are adapting manufactured materials to local needs or buying clothes in markets.

3.3.3 *Other Material Changes*

Utensils, tools and other household equipment are readily available in local markets throughout the country. In villages there are still some local blacksmiths in remote villages and in Hmong villages where metals are recast into tools, knives and weapons but this is becoming rare.

Traditional weaving in bamboo and rattan is still practiced widely through the region and provides some income for a number of ethnic minorities.

3.4 **Language**

3.4.1 *Present Language Status and Usage*

Lao PDR not only has a rich diversity of ethnic groups but languages from four major linguistic families are spoken in the country, each family being represented by a number of languages and dialects. The grouping of ethnic groups in Table I-1 above is based on ethno-linguistic characteristics, language being the most common way to classify ethnic groups.

One needs to distinguish between the status and usage of the main language groups. The following five categories are outlined to provide an overview.

Majority Group – Lao National Language

Approximately, 35-40% of the present population speak Tai Lao or Lao, the national language of the country as a first language only. Most do not have knowledge of other languages but some may have a passive knowledge of other Tai Lao dialects and languages if they reside within the same area. Most Lao speakers in the project area and surrounding areas reside in the lowlands, along the Mekong or in urban and semi-urban areas throughout the country. These groups dominate government services, including education. This language is the only one that is expanding in terms of first language users as more parents teach their children Lao and more ethnic minorities change from being bilingual to being primarily Lao-speakers (see Section 3.3.2 below).

Other Tai-Lao Languages

Approximately, 25-30% of the country's population speak a Tai-Lao languages other than Lao: Phou Thay, Lue, Tai Daeng, Tai Dam, Pouane, Sek, etc. Nearly all of these communities speak Lao in addition to their mother tongue, and in many cases Lao is merging with or replacing these languages and dialects, which are similar to Lao. In some cases, such as Tai Bo and Lao Kaleung in the NT2 Project area, one should classify these languages as Lao dialects since they are mutually understandable. It is only in the more remote areas of the country where these Tai-Lao languages are spoken. There is a clear tendency for these languages to be spoken only in the domestic sphere and only in communities that are all members of that ethnic group. Inter-marriage, increased contact and mobility as well as Lao schools and media, have resulted in many of these groups are losing their dialects and languages.

Brou and other Mon-Khmer Speakers

Mon-Khmer languages are very dissimilar to those of the Tai-Lao family of languages. About 20-25% of the population speak these languages as their mother tongue at present but this is changing rapidly in some part of the country,

especially in areas like Nakai (Brou/Makong) where there is mixing of many ethnic groups or where there is considerable in-migration of Tai Lao groups, such as along transportation corridors.

Hmong Speakers

The language status of the Hmong varies to some extent depending on the location and degree of integration. In general most adult men and children are bilingual while the degree of bilingualism varies greatly among the elderly and women from Hmong speakers only in remote areas to completely bilingual communities. Hmong is also a written language using both Chinese script (ritual specialists and some elders) and using a modified Latin script. The Hmong language may be described as 'stable' in that Hmong groups still use their language extensively.

Vietic and other small minorities

There are numerous Vietic languages spoken by many small communities in the project area and surrounding areas. These languages are not mutually understandable and some are endangered of disappearing since the number of speakers is very low, below 50 in some cases. Most Vietic speakers are bilingual or even trilingual depending on location. However, there is an incredible range of language status, from solely Vietic speaking (women and elderly in remote areas) to only speakers of Lao (young people on the Nakai Plateau and near Lakxao).

3.4.2 *Trends in Minority Language Usage*

There may be several reasons why Hmong is not disappearing like other minority languages: the tightly-knit clan organisation of the Hmong, the relatively recent arrival in central Lao and the different cultural values, religion and other characteristics of the Hmong. The following table summarises the situation for the main ethnic groups in the region:

Table 4: Language Trends for Ethnic Minorities

Ethno-linguist Category	Main language(s)	Trend
Lao	Lao	Increased use of Lao in interaction with other ethnic minorities Language of government and education
Phou Thay	Phou Thay and Lao	Lao language merging or replacing Phou Thay
Upland Tai	Tai dialects and Lao	Lao language merging or replacing Tai dialects
Bo, Nyo, Yooy, Kaleung, etc.	Bo, Nyo, Yooy, Kaleung, etc. and Lao	Lao language merging or replacing Bo, Nyo, Yooy, Kaleung, etc.
Brou (Makong)	Brou and Lao	Lao language replacing Brou
Vietic	Vietic languages and Lao (dialects)	Lao language replacing Vietic dialects and languages
Hmong	Hmong and Lao	Hmong and Lao (bilingualism)

3.5 Religious Practices

3.5.1 *Buddhism and Traditional Cultural Beliefs*

Most ethnic minorities in the area combine traditional beliefs with Buddhism to varying degrees. The Vietic, some Sek and some Tai groups have little or no Buddhist influence while some Brou and Tai in the lowland areas profess to believe in Buddhism. In most cases, as can be argued for the lowland groups as well, there is a co-existence of traditional spirits (territorial, forest, evil and ancestral) and Buddhist Canon (merit-making, incarnation, moral precepts, monastic codes and ordination of males for short periods into the monkhood).

Buddhism and traditional beliefs are integrated into one system that is operationalized in different way depending on particular needs and pragmatic considerations. Most practitioners, including monks, utilise both systems simultaneously, combining Buddhist texts as magical spells and using the pantheon of gods and spirits to intervene on behalf of the living.

3.5.2 *Changing Religious Practices*

The general trend is for the spread of Buddhism into remote areas – this organised religion with written texts and monasteries represents modernisation in the eyes of many minority groups. Lao ritual specialists (*mô*) and monks conduct rituals in minority villages. Examples of this are:

- Traditional burials being combined with Buddhist notions of cremation and merit-making for the soul
- Lao Baci ceremonies for recovery from illness and tying the spirit (*khwan*) to the body becoming common
- Former monks becoming ritual specialists in minority villages, combining what they have learnt in monasteries (often very superficial) with local beliefs and practices
- Recent establishment of monasteries and restoration of old monasteries occurring, such as in Nakai Town

3.6 Migration, Relocation and Urbanisation

3.6.1 *Natural Population Increase*

At the moment, many ethnic minority areas of the country seem to be entering a period of ‘demographic transition’ whereby family size is still large (6-9 children quite common in rural and remote areas) but morbidity and mortality rates are decreasing as medical services gradually increase and cover a greater areas of the country. UNDP reports a natural population increase of about 2.2% for the country as a whole. Population increase among the Brou, the largest group in the NT2 Watershed, certainly exceeds this rate but specific statistics are not available. Estimates for predicting population increase on the Nakai Plateau for resettlers are estimated at a 3% annual increase, reflecting a higher population rate increase than in lowland areas.

3.6.2 *Migration to Roads*

The case study on migration presented below – migration and population change along NR8 – clearly show that improvements in roads and infrastructure in general attract large numbers of people, not only from the nearby region but from all over the country. Population increases of double the national growth rates in not uncommon since so much of the country lacks basic services and infrastructure. The promise of work and the opportunities to conduct various types of business are also key factors.

Population Change along National Road 8

Population change along NR8 over an eight-year period provides an interesting example of how large infrastructure projects, in this case the upgrading of a main road and the indirect impacts from the Theun Hinboun Hydropower Project, can lead to increased population in the impacted area. The example also reveals how voluntary and involuntary resettlement are contributing factor to urbanization, integration of ethnic minorities and government programmes to reduce swidden cultivation and provide services through village consolidation.

Data collected in 1995 and 2003/04 identify and indicate the main trends:

- Increased population along NR8 due to in-migration
- Total number of villages decreased due to consolidation into administrative units and larger villages
- Disappearance of smaller and remote villages in the region

There is tendency for villages to be consolidated, either through spontaneous movement to roads and service centers or as part of a focal zone strategy. The main trend is that people moved towards the main road, Route 8 and the population density along this road has grown significantly from 1995 to 2003/04. Taken into account that the population growth in Laos is 2.2 % (*Human development Indicators, UNDP 2003*) for this period, the regional population growth in the survey area is much higher, closer to 4% as a yearly average. This implies that there has been a significant in-migration into the area during this 8-year period, and that many new tenants have settled along Route 8. One reason for this can be the accessibility to markets, because Route 8 has been upgraded several times and is now considered as a secure link to markets in other regions, including Vietnam.

The areas with the biggest expansion and population growth have been Lak Sao and Nongpong along Route 8 to the Vietnamese border and below the Nam Theun where the number of households have more than doubled during the last 8 years, while national average was about 20 % increase over the same period. The Nam Kata Area south of Lak Sao has had the smallest expansion, which is just above the national average.

Another clear trend is that the total number of villages in the survey area has decreased dramatically from 100 in 1995 to 45 registered in 2003/04. One reason for this is that several villages have consolidated into larger administrative units. Of the total 100 villages in 1995 about 25 of these small villages have merged together with a bigger nearby village to form a common administrative unit. Other villages have been abandoned and whole villages have moved to a new site or to the bigger villages. The statistics indicate that approximately 28 villages have been abandoned the last 8 years while the numbers indicate that the villages that were either abandoned or have formed new administrative larger units had beneath 50 households in 1995.

The data from 2003/04 point to the fact that people prefer to live in bigger villages near to roads and markets. The number of villages with more than 100 households increased from 8 in 1995 to 29 in 2003/04. The biggest village at present in this area is Nongpong with 488 households and a population of 2435 people. The number of small villages with less than 50 households and separate administration has decreased dramatically from 45 to 2 households during this same period. In numbers medium villages, with between 50 to 100 households, have not increased significantly but there have been a relatively great flow through. The trend is that medium villages in 1995 have expanded into big villages during the 8 years and small villages have either expanded to be medium villages or been abandoned during the same period. Table 1 summarizes the village sizes in the analysis area.

Table 5: Village Size 1995 and 2003/04

Unit / Year	1995	2003/04
Abandoned village	-	28
New Administrative Units	-	27
No data	37	-
0 - 50 households	45	2
50 - 100 households	10	14
< 100 households	8	29

Another trend is that smaller ethnic minorities, especially many of the Vietic groups that have recently changed from hunter-gatherers to swidden cultivators and are still heavily reliant on forests, have relocated or been resettled by government programmes into larger villages. This will result in further integration into the mainstream economy but there is a risk that majority groups will dominate these small and more vulnerable groups.

3.6.3 *In-migration*

In-migration into the NT2 Project area or surrounding areas is changing the demographic balance between the indigenous peoples and ethnic minorities on the one hand and lowland peoples who are often more educated and have more resources and knowledge. An example is the in-migration into the Nakai Plateau, first to Nihom 3, a government-run farm for soldiers of the former regime and then to Nakai Town, the new District Capital of Nakai. The majority of new arrivals are Lao, Kaleung, Phou Thay and other Tai groups from surrounding districts in the lowlands, and these groups dominant trade, services and government positions.

3.7 **Socio-Economic Development**

3.7.1 *Economic Development*

The basic trend is one of change from a subsistence economy with barter and kinship obligations to one depending on supply and demand and cash. This transition favours those groups with experience in buying and selling in the market

place, not ethnic minorities emerging from traditional economic systems. Many ethnic minorities do not understand the workings of market system or the underlying principles.

An example is how villages on the Nakai Plateau agree to supplying middlemen with NTFPs at an unsustainable rate of harvesting them, resulting in longer and longer periods away from the village to collect them and an eventual disappear of some NTFPs on the Plateau and farther off. Another example is how in the village of Sop Hia, near the NT2 proposed damsite, have reportedly over-fished in the area in order to supply fishmongers at the markets in Lak Sao. This boom lasted a short time until the fish could not replenish themselves and now villages cannot find enough fish to eat (reported during field visit in 2002).

3.7.2 *Health Services*

Ethnic minorities are poorly serviced by health facilities and personnel in general. This is due to their relatively remote locations and a lack of funds to carry out government programmes. Despite some successes, notably the near eradication of Malaria from parts of the NT2 Project area, much needs to be done. Morality rates are double for many ethnic minorities (ADB 2001c).

Most minority groups practice a type of eclectic form of medicine, that is combine natural herbal remedies with modern scientific approaches. This often involves decisions based on traditional belief in spirits, theories of causality (balance of fluids and temperature in the body) and a partial understanding of the workings of Western medical practices. Improving health infrastructure and services does not always take into account traditional practices and working with traditional healers and local knowledge. Hence, the approach to solving some of the health problems can actually lead to the loss of local knowledge and experience.

Traditional healers like the *mô yaa* and *mô thiem* are disappearing and the next generation does not seem interested in learning these techniques that combine beliefs in spirits and medical cures, healing the body and the mind. However, there are curious combinations and eclectic approaches continue to dominate. The optimal approach is to combine local knowledge and learning with new techniques but this requires an appreciation of this knowledge and a willingness to integrate it into modern approaches that is often lacking in government and donor solutions.

3.7.3 *Education Services*

The general trend is for more and more rural communities to have functioning primary schools and more children completing these schools. Standards vary but the level of literacy in the Lao language has been increasing significantly since the mid-1990s. A recent study of minority villages along NR9 indicates a significant increase in attendance (Benefit Monitoring Report, Kampsax 2004). However, elsewhere studies have indicated that many ethnic minority children are disadvantaged by Lao medium schools at the primary level and a lack of local teachers familiar with ethnic languages and cultures. Clearly access to schools is not the solution alone. Much depends on the quality of the education and how teachers are familiar with local cultures.

As the Lao education system expands it may do so at the price of minority languages. Literacy is only gauged in the national language (cf ADB 2001b and 2001c).

3.8 Political Integration

3.8.1 *Replacement of Traditional Structures*

One aspect of 'nation-building' is the integration of outlying communities into the mainstream political system, that is introducing organisations and structures at the local level that are ultimately linked to the central government. Traditional societies, however, have their own local social organisations and 'political systems', system in the broad sense of decision-making, power and influence. In the case of Lao PDR, many regions of the country, due in part to the lack of infrastructure, have been fairly autonomous until relatively recently. Different ethnic groups have had different organisational forms. Several aspects are worth noting:

- Leadership based on founding families or leading families of influence is being replaced by candidates approved by district governments
- Leadership based on traditional knowledge and respect in the community is being replaced by literacy, experience of the outside world and membership in the Lao Socialist Party
- Clans and kinships networks as forms of social organisation and local hierarchy are being challenged by wealth and influence based on wages, government jobs, business success and other economic factors

3.8.2 *Parallel Power Structures*

It is reported that on the Nakai Plateau (Sparkes 1997) there are parallel power structures at the village level. Some traditional leadership positions are being marginalised, such as the *Tao Khun*, from a general position of leaders for the community to a group overseeing only cultural events such as marriages and rituals. Politically approved village leaders are supported by district authorities. In addition, members of the Socialist Party of Lao often hold key positions in the village and function as the government's eyes and ears in the villages. The result is that there may be considerable overlap and villagers are often not aware of the roles of the various mass organisations – National Front for Construction, Youth Organisation, Lao Women's Union, Militia and formal leaderships positions.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Ethnic Minorities and Global Trends

4.1.1 *Nation State and Multicultural Diversity*

There is a global trend for recently established states, especially those with an ethnically diverse population, to engage in ‘nation-building’, that is a consolidation of control over peripheral areas and the promotion of national integration through the establishment of shared cultural, economic and political values. For Lao PDR, the promotion of national unity is a high priority for the government. The result of this is a series of programmes and policies that favour cultural integration. Although the constitutions and various government organisations propose to promote cultural diversity and protect the rights of all ethnic groups, existing policies promote lowland Lao culture only:

- Lowland livelihood systems based on paddy cultivation – halting of swidden cultivation
- Education system in Lao
- Promotion of Lao language for government services
- Spread of Buddhism as a ‘national religion’
- Centralised political system and ideology dominated by lowland Lao groups

There is no policy discriminating against ethnic diversity but little in the way of actively promoting ethnic difference. There are no policies for socio-economic or political autonomy for ethnic groups, and it is difficult to image that the present ethnic minority diversity will survive the present development trends without active interventions.

4.1.2 *The Cost of Ethnic Diversity*

Without the active promotion of ethnic diversity, it is likely that many groups will disappear or merge with the dominant lowland Lao culture. This process of assimilation and integration is ongoing and there are many examples of this in the NT2 Project area and surrounding areas, such as the Nakai Plateau, along transportation corridors and in urban areas.

The cost of extensive plans for maintaining and promoting cultural diversity are presently beyond the scope of the government that is struggling to bring a significant percentage of its population out of poverty and to supply essential services – electricity, roads, schools and medical facilities to rural communities.

For example, in order to retain the existing language diversity, it will be essential to conduct primary education in minority languages. This would involve transcribing ethnic languages into the Lao script, translating textbooks, adapting materials, training local teachers and monitoring and adapting results to suit the needs of specific minority communities. Most of the minority languages are not written down and the levels of literacy are very high among most groups. The cost of such programmes would be prohibitive for the government. Seen in the light of

existing levels of poverty and serious issues like food security and essential services, it is easy to understand why such programmes are unlikely to happen in the near future or even for the 20-year scenarios.

4.2 Scenarios for Nakai Plateau

4.2.1 5-year Scenario

Except for the new arrivals (mostly Lao, Kaleung and Phou Thay) in Oudomsouk town, the newly established district capital of Nakai, almost all of the inhabitants on the Nakai Plateau are ethnic minorities as defined in the EMDP (May 2004): Brou/Makong, Tai Bo and small groups of Vietic. However, there is a clear trend towards integration and assimilation of the groups on the Plateau into mainstream Lao culture. With the arrival of educated and more resourceful lowland Lao during the construction period (**5-year** perspective) and the already noticeable increase of majority groups in the district capital, the ratio of ethnic minorities in relation to lowland Lao and related groups is likely to change. At present the ratio is approximately 1:5 in favour of the minorities with the lowland groups mostly located in the district capital and in small numbers along the existing roads. It is likely that this ratio will have changed to 1:3 due to influx of outsiders. Because of the changes outlined in the proposed livelihood systems, education improvements (in the Lao language), newly established Buddhist monastery and the existing mix of culture, the so-called 'melting pot of the Plateau', a local Lao culture will develop consisting of Lao language (regional dialect) and local cultural characteristics. The project is likely to further hasten this process of integration.

4.2.2 20-Year Scenario

In the **20-year** perspective the communities on the Nakai Plateau will likely be fully integrated into the mainstream Lao culture and nation state. This implies that the Nakai culture will be a Lao culture (Buddhism, Lao language and Lao government institutions) without many of the common characteristics of Ethnic Minorities, such as reliance on natural resources, unique cultural traits, languages and institutions. Inter-marriage between groups is likely to increase and present ethnic identities (Bo, Brou, Sek and Vietic) are likely to be further blurred or even forgotten. It is also likely that people will start to define themselves as *Lao Loum* (lowlanders or dominant group) or as Tai Nakai (Tai-Lao group of the Nakai region) as is already the trend among some residents of Nakai.

4.2.3 Recommendations

There is some concern that smaller ethnic groups may be marginalised or may not adjust as well as larger groups or Tai-Lao inhabitants of the Plateau. Since NT2 Project activities will dominate this area completely during construction and as a result of resettlement activities, much will depend on the success of project mitigation and monitoring. Specific measures have been identified for vulnerable groups and ethnic minorities and these need to be carried out with care and considerable follow-up to ensure that the Vietic groups and other less resource minorities, such as the Tai Bo in more isolated areas benefit from livelihood development.

Considerable efforts will be needed to strengthen institutions and organisations that are responsible for consultations and livelihood development for the different minorities. The application of legal measures governing rights land and resources

are central for the long-term well being of the different ethnic minority communities. Additional resources in terms of manpower and training will be required by Vietic groups in particular since they are less integrated and less familiar with the proposed livelihood development options.

In sum, what is required is a careful monitoring programme, including internal and external monitors with ethnic minority and anthropological experience. The plans and provisions for the development of ethnic minorities are extensive but the implementation and monitoring will require considerable resources and skills both on the part of the government and the project.

4.3 Nakai-Nam Theun NBCA

4.3.1 5-year Scenario

In the **5-year** perspective the situation for the ethnic minorities of the NBCA (Brou, Sek and Vietic) will differ considerably from the Nakai Plateau since these groups are less integrated and will not experience directly the influx of lowland culture. However, some groups may attempt to find work, to increase economic interaction and even to relocate to the Plateau during the construction period. This is likely to lead to some integration but not to the same extent as with the Plateau communities. The livelihood development schemes outlined in the SEMFOP-1 (April 2004) may act to slow down this process and counter to some extent the temptation to migrate to the Plateau. It is unlikely, however, that large number will migrate out of the area given the relative abundance of natural resources.

4.3.2 20-Year Scenario

For the **20-year** perspective there will be increased contact with the Nakai Plateau, both economically and culturally, the relative isolation of the various ethnic minorities in the NBCA will no longer be to the same extent as before. Government institutions and services will expose groups to lowland cultural traditions, reorienting the areas towards Nakai away from markets in Lak Sao. It is likely that many households may chose to leave this area for the better standards of the Nakai Plateau, where some of them have relations. Most ethnic minorities have relations to those residing on the Plateau. It is possible that the natural population increase in the NBCA will be countered by considerable out-migration. Labour migration, both seasonal and to urban areas for longer periods, may become common among some groups. Those remaining in areas outside of the watershed are likely to integrate culturally with Lao, replacing many of the ethnic languages and local beliefs being modified by Lao customs, traditions and Buddhism. Small Vietic groups are unlikely to retain their ethnic identities and will probably be integrated into larger ethnic groups like the Brou or adopt Lao identities. Since these groups are extremely vulnerable and presently exploited by others, considerable support and interventions are required or many of the Vietic communities will disappear.

4.3.3 Recommendations

The most pressing issue for the ethnic minorities of the NBCA is the survival of the Vietic groups in viable communities. The present situation for these groups varies but most communities have been marginalised and out-competed by other groups entering into their traditional territories. Many communities have been resettled as part of a GOL initiative to consolidate villages since the late 1970s.

Vietic groups have adjusted badly on the whole to sedentary farming and lack the skills and resources to create sustainable livelihoods. In addition, there is evidence that some groups are being exploited by Hmong, Tai and Brou communities – some Vietic have become opium addicts.

The following recommendations are needed in order to address these issues in the context of ‘best practice’. What is needed is a pro-active approach:

- Specific interventions tailored to Vietic communities
- Ensuring participation in decision-making, such as representation on local bodies and an open and transparent conflict-resolution mechanism
- Separation of Vietic households and communities from other ethnic groups
- Option to return to traditional territories inside the NBCA and assistance to develop livelihoods in those locations
- Training and preference for jobs as wardens, rangers, research assistants and guides for eco-tourism
- Intensive monitoring and training for GOL staff involved in working with such groups –supervision by international anthropologists

4.4 Scenarios for Xe Bangfai and Surrounding Districts

4.4.1 5-year Scenario

The SDP for the XBF and Downstream areas identifies a number of ethnic minorities. These minorities, unlike those on the Nakai Plateau, share a common livelihood system with the Lao, Phou Thay and other Tai-Lao (*Lao Loum*) groups in this area. There are some differences in terms of cultural practices, income levels and degree of urbanisation, but in terms of socio-economic status the Brou or Makong of the Nam Phit and Xe Bangfai, as well as other Kautic (Mon-Khmer) groups in adjacent districts, are similar in terms of socio-economic development. Given the fact that all groups should benefit from potential development of irrigation, improved infrastructure and services, it is likely that economic integration will not be at the price of social and cultural assimilation in the **5-year** perspective. Most Brou and other minorities will remain bilingual and retain local traditions to a large extent in rural areas.

Data from National Road 9 (upgraded) also support this trend for Brou (Makong) and Tri communities in neighbouring Savannakhet Province (see Benefit Monitoring Report, Kampsax 2004). However, it is important to note that ethnic minorities in more isolated areas, such as along rivers (Middle XBF) and at some distance from transportation corridors (villages more than 20 km from NR9 – confer ADB Rural Community Access Improvement EMDP, 2002-2004), require additional assistance since they lack the skills and resources to adapt new livelihood systems. If specific measures are not introduced to protect the rights of these groups, it is likely that outsiders with more resources and greater skills will marginalise these vulnerable groups.

4.4.2 20-Year Scenario

In the **20-year** perspective, the ethnic minorities in the downstream districts are likely to retain their identity to some extent in rural areas although a gradual integration into the mainstream economy and culture will occur. This is due to the fact that there are large clusters of Brou in Gnommalath and Mahaxai Districts and Tri in Savannakhet province, unlike the mix of ethnic groups on the Plateau and small isolated groups in the NBCA. Lowland Lao will dominate towns and urban areas and minority households residing at these locations will probably lose their identities and merge with the local Lao groups to some extent. Buddhism may replace or subsume many of the non-Buddhist or animist traditions in the area, a process that has been ongoing for at least a century. Since virtually all education, official interaction and business is in Lao, the Brou and Tri languages will remain predominant only in the domestic setting and in villages where the Brou or Tri are dominant. Other smaller ethnic groups or isolated pockets are likely to merge with Lao, such as the Suay along NR9.

4.4.3 Recommendations

The key concern is to ensure that ethnic minorities in these mixed areas of predominantly Tai-Lao groups are able to develop on a par with majority groups and can benefit directly and indirectly from the impacts of NT2, in particular from irrigation potential and infrastructure improvements. A pro-active approach is needed that specifically targets ethnic minorities in a number of ways:

- Special training programmes to ensure active and meaningful participation in programmes on a par with majority groups (compensating for a lack of skills and experience)
- Land use planning and ensuring rights to land and resources – linking up with GOL and donor programmes – to guard against outsiders moving into ethnic minority territories and extracting resources such as timber and NTFPs in an unsustainable manner

4.5 Scenarios for Nam Theun, Nam Kading, Nam Hinboun and Surrounding Districts

4.5.1 5-year Scenario

The ethnic population of Khamkeut District of Bolikhamxai, including the town of Lak Xao, is very mixed. The majority residing in this district belong to the broad category of *Lao Loum* or lowland groups, including various Tai sub-groups. There are also populations of Hmong, Mon-Khmer (Brou) and smaller groups, including Vietic (Maleng, Liha, To'e and other groups) along the areas bordering the NBCA. Like other districts in and adjacent to the NT2 project, there is likely to be increased integration in terms of social, economic and cultural development. A particular concern for this region are the small vulnerable Vietic groups who are more susceptible to assimilation due to their small population numbers, relative isolation, reliance on natural resources and lack of understanding of market forces. Their future is uncertain at a time of rapid socio-economic change.

Another issue is the swidden practices of the Hmong adjacent to the NBCA and the potential threat to biodiversity. In the **5-year** perspective, the most likely situation will consist of the gradual integration of groups into the mainstream economy being sped up slightly by NT2 project-related activities, population influx, in-

creased urbanisation, consolidation of smaller groups into larger village administrative units, improved infrastructure and growth in the service sector.

4.5.2 *20-Year Scenario*

In the **20-year** perspective, it is likely that smaller ethnic groups in or near Lak Xao, including the Vietic populations, will become more assimilated and may lose their ethnic identity to a large extent if GOL resettlement and integration programmes continue. Groups related to Lao, such as Phou Thay and Tai sub-groups, are likely to become fully assimilated in urban areas, but in rural areas cultural differences will continue to some extent. Buddhism will replace some local beliefs and the Lao language will gain ground, leaving local languages and dialects only the domestic sphere for expression. Hmong cultural traditions and language are likely to continue despite changes in the socio-economic condition due to the fact that Hmong clan structure is strong and there is a large network of Hmong groups within Lao PDR and abroad.

4.5.3 *Recommendations*

The following are the recommendations for ethnic minorities in the Nam Theun, Nam Kading, Nam Hinboun and surrounding districts:

- Specific interventions tailored to Vietic communities
- Separation of Vietic households and communities from other ethnic groups, especially the Hmong who are exploiting and out-completing them for the natural resources in the Vietic traditional territories
- Option to return to traditional territories inside the NBCA and assistance to develop livelihoods in those locations
- Training and preference for jobs as wardens, rangers, research assistants and guides for eco-tourism
- Intensive monitoring and training for GOL staff involved in working with such groups –supervision by international anthropologists
- Specific interventions for the Hmong communities bordering the NBCAs for livelihood development
- Halt to all programmes for resettlement and in-migration schemes in areas bordering the NBCAs – population increase will continue to threaten these areas especially if there are no detailed livelihood development programmes

4.6 **Scenarios for Vietnamese Provinces**

A detailed scenario for ethnic minorities residing in Vietnam bordering the NT2 Project area. Of particular concern are the areas adjacent to the Nakai-Nam Theun NBCA. It can be assumed that the process of assimilation and integration as described in detail above for the minorities in Lao PDR, will be similar. In both countries the present status of the Brou/Bru-Vân Kiều and Vietic/Chút is comparable in many respects. The future of these groups will depend on the programmes carried out by the government of Vietic – whether they aim to fully inte-

grate minorities or whether specific projects and programmes will be tailored for the needs of these minorities.

One recommendation is to establish mechanisms to share common approaches for group residing inside or in buffer zone of national biodiversity areas. This should form part of a coordination mechanism for managing these important areas of biodiversity in terms of conservation management and sustainable social development.

REFERENCES/BIBLIOGRAPHY

- Asian Development Bank (ADB), 1998. *Indigenous Peoples' Policy*. ADB, Manila.
- ADB, 2001a. *Participatory Poverty Assessment, Lao PDR*. State Planning Committee, National Statistics Center, Vientiane.
- ADB, 2001b. *Indigenous Peoples/Ethnic Minorities and Poverty Reduction*. Proceedings of a Regional Workshop. ADB, Manila, 25-26 October 2001.
- ADB 2001c. *Health and Education Needs of Ethnic Minorities in the Greater Mekong Subregion*. ADB, Manila.
- Batson, Wendy, 1992. 'After the revolution: Ethnic minorities and the new Lao state' in J. Zasloff and L. Unger (eds.), *Laos: Beyond the Revolution*. Macmillan, London.
- CARE International, 1996. *Socio-Economic and Cultural Survey of the Nam Theun 2 Project Area, Lao PDR*. Care Int. Lao PDR, Vientiane.
- Carol, J. and W. Randall Ireson, 1991. 'Ethnicity and development in Laos' in *Asian Survey*, Vol. 31, No. 10, pp. 920-37.
- Chazée, Laurent, 2002. *The Peoples of Laos: Rural and Ethnic Diversities*. White Lotus, Bangkok.
- Dang Nghiem Van, Chu Thai Son and Luu Hung, 1993 *Ethnic Minorities in Vietnam*. The Gioi Publishers, Hanoi.
- Evans, Grant, 1999. *Laos: Culture and Society*. Silkworm Books, Chiang Mai.
- Evans, Grant, 2003. 'Laos: Minorities' in *Ethnicity in Asia*. Mackerras, Colin (ed.). Routledge, London.
- Government of Lao PDR, 2003, *the National Poverty Eradication Programme (NPEP), Background Document*
- Government of Lao PDR - Nam Theun 2 Watershed Management and Protection Authority, 2002, *Social and Environment Management Framework and 1st Operational Plan*
- Government of Lao PDR - Nam Theun 2 Watershed Management and Protection Authority, 2002, *Social and Environment Management Framework and 1st Operational Plan, Folio of Annexures*.
- Kampsax, July 2004. *Benefit Monitoring Report: Final Project Report for NR9*. Kampsax, Vientiane.
- Mackerras, Colin (ed.), 2003. *Ethnicity in Asia*. Routledge, London.
- NORPLAN, 2003. Resettlement Action Plan and Ethnic Minorities Development Plan for Rural Community Access Improvement (RCAI), East-West Corridor Project Coordination. Dept of Roads, Ministry of Industry and Handicraft, Vientiane.
- NTPC 2004, *Social Development Plan – Four Volumes*. Advanced Drafts – April-July 2004.
- Ovesen, Jan, 1993. *Anthropological Reconnaissance in Central Laos: A Survey of Local Communities in a Hydropower Project Area*. Uppsala Research Reports in Cultural Anthropology.
- Rambo, A. Terry, 2003. 'Vietnam' in 2003. *Ethnicity in Asia*. Mackerras, Colin (ed.). Routledge, London.
- State Planning Committee, National Statistical Centre, 1997, *Results from the Population Census 1995*,
- State Planning Committee, National Statistical Centre, 2002, *Statistical Yearbook 2001*.

Tapp, Nicholas, 1989. *Sovereignty and Rebellion: The White Hmong of Northern Thailand*. Oxford University Press, Singapore.

Tonkin, Elisabeth, Malcolm Chapman and Maryon McDonald (eds.) 1989.

Vargyas, Gábor, 2000. *A la recherche des Brou perdu, populations montagnarde du Centre Indochinois*. Les Cahiers de Peninsule, No. 5, Etudes Orientales/Olizane, Sorbonne, Paris.

Vatthana Pholsena, 2002. 'Nation/representation: Ethnic classification and mapping nationhood in contemporary Laos' in *Asian Ethnicity*, Vol. 3, No. 2, pp. 175-97.

World Bank, 1991. *Operational Directive 4.20: Indigenous Peoples*. World Bank Safeguard Policies, Washington D.C.

APPENDIX A: TERMS OF REFERENCE

**Lao PDR
Nam Theun 2 Hydropower Project**

Cumulative Impact Assessment

Terms of Reference

17 November 2003

TABLE OF CONTENTS

- A. Overview**
 - Introduction
 - Proposed Project
 - B. CIA Study**
 - Introduction
 - Rationale
 - Complementary Studies
 - Scope
 - C. Tasks**
 - D. Reports**
 - E. Consultant Supervision and Time Schedule**
 - F. Staffing and Experience of the Consulting Firm**
 - G. Schedule of Payments to the Consultant**
- Annex I: Description of Key Issues and Questions**

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
CIA	Cumulative Impact Assessment
EAMP	Environmental Assessment and Management Plan
EMDP	Ethnic Minorities Development Plan
EdF	Electricite de France
EdL	Electricite du Lao
GoL	Government of the Lao People's Democratic Republic
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
Lao PDR	Lao People's Democratic Republic
MIGA	Multilateral Investment Guarantee Agency
MRC	Mekong River Commission
NBCA	National Biodiversity Conservation Area
NGO	nongovernment organization
NTEC	Nam Theun 2 Electricity Consortium
RAP	Resettlement Action Plan
SDP	Social Development Plan
SEMFOF	Social and Environmental Management Framework and Operational Plan
WBG	World Bank Group

**Proposed Nam Theun 2 Hydropower Project
Cumulative Impact Assessment (CIA)
Terms of Reference**

A. Overview

1. **Introduction.** The Government of the Lao People's Democratic Republic (Lao PDR) seeks to undertake the proposed Nam Theun 2 Hydropower Project (Project) in cooperation with Nam Theun 2 Electricity Consortium (NTEC), a private sector investor including the participation of Italian-Thai Development Public Company Limited, Electricity Generating Public Company Limited and Electricité de France International. In addition, the proposed project is being considered for financial support from the Asian Development Bank (ADB) and the World Bank Group (WBG), acting through the International Bank for Reconstruction and Development (IBRD), International Development Association (IDA) and Multilateral Investment Guarantee Agency (MIGA). It is anticipated that other international financial institutions and bilateral donors may participate in funding the proposed project.

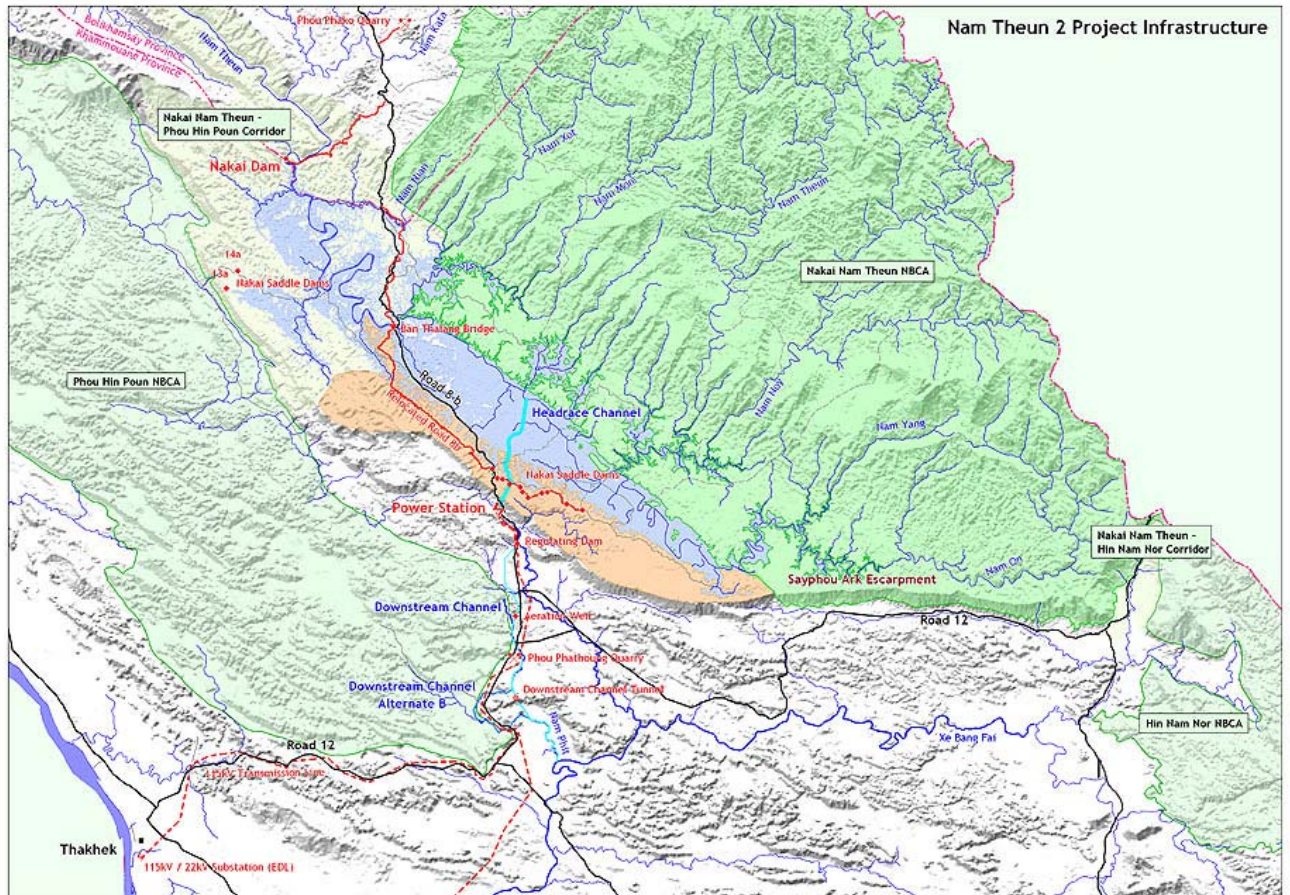
2. **Proposed Project.** The proposed transbasin Nam Theun 2 hydropower project is located in Khammoune, Bolixamsay and Savannakhet provinces in Central Lao PDR. As currently configured, the project includes the development, construction, and operation of a thousand-Megawatt hydropower facility primarily for export of power to Thailand. The project will divert water from the Nam Theun River in the Nam Kading River Basin, to the Xe Bang Fai River in the Xe Bang Fai River Basin (see Figure 1).

3. The main hydraulic features of the project are a 48-meter high gravity dam on the Nam Theun river, a 450 sq. km. reservoir on the Nakai Plateau, a power station located approximately 40 km upstream of the dam site, a headrace channel and intake structure to supply water from the reservoir to the power station, a discharge channel and control works to transport water from the power station to the Xe Bang Fai River.

4. Operation of the project will result in substantially reduced flows in the Nam Theun River downstream of the new Nakai dam, upstream of the existing Theun-Hinboun dam. The Theun-Hinboun dam and reservoir also effects inter-basin transfer of water between the Nam-Kading River (reduced flows) and the Hinboun River (increased flows) both of which discharge to the Mekong River upstream of the confluence of the Xe Bang Fai. Weekly average flows in the Nam Theun River downstream of the dam will be 2 m³/s. Natural flows in this part of the Nam Theun are 20 m³/s during the dry season and 1,500 m³/s during the wet season. Typical water flow through the power station to the Xe Bang Fai will be 280 m³/s. During the dry season, this will approximately double flows in the Xe Bang Fai downstream of the confluence of the discharge channel. During the wet season, the flow increment will be approximately 10%¹ of the natural river flow. Discharge from the station is to be managed to not increase the magnitude of floods in the Xe Bang Fai downstream of the project.

¹ To be confirmed with the water balance hydrology study.

Figure 1: Proposed Nam Theun 2 Hydropower Project Location Map



5. The project will involve an extensive social and environment component. The major features of the component are: (i) the resettlement and restoration of livelihoods of 5,000 people from the reservoir area; (ii) the provision of funding for the conservation of the Nakai-Nam Theun National Biodiversity Conservation Area (NBCA) and the adjacent Corridors; (iii) mitigation programs for the downstream effects in the Xe Bang Fai River; (iv) environmental monitoring and adaptive management measures including the operation of the dam and wildlife management on the Nakai Plateau.

6. A 130km. long double-circuit 500kV transmission line will be constructed to deliver the electricity produced to the Thai grid. A 70-km. long single-circuit 115 kV transmission line will be included to carry the small portion of the total electrical output that will be dedicated to domestic use. The existing road access to the Nakai Plateau will be substantially upgraded and the road will be realigned in some locations where the present alignment will be inundated by flooding of the reservoir.

B. CIA Study

4. **Introduction.** Consistent with the environmental and social safeguard policies of the ADB and WBG, the Consultant will prepare a Cumulative Impact Assessment (CIA) study that will examine the aggregate impacts from: (i) the construction and operation of the proposed project and, (ii) potential scenarios for development that could also affect the environmental and social dimensions impacted by the proposed project.

5. **Rationale.** Over time, the proposed NT2 Hydropower project is expected to have direct and indirect environmental and social impacts in its immediate area of influence and beyond. Consistent with ADB and WBG safeguards policies, environmental and social mitigation plans were prepared and will be carried out to mitigate, offset, reduce negative impacts and strengthen positive impacts on the environment and communities in the Project area. At the same time, regional development will be taking place including potential development in many sectors such as: navigation, roads, hydropower, irrigation, urban development, forestry, fisheries, mining and conservation. The impacts of NT2 Project combined with the potential impacts of existing, planned and/or proposed projects in the Project area and in the Greater Mekong Subregion need to be taken into account to ensure Lao PDR and other countries in the Subregion may effectively enhance the benefits and reduce the impacts from such projects. The study is intended to be used as an advisory tool for medium- and long-term development planning in the project area and in the Greater Mekong Subregion.

6. **Complementary Studies.** The CIA will complement a series of environmental and social studies being prepared to evaluate the impacts and risks of the proposed project. These documents include, but are not limited to: (a) Environmental Assessment and Management Plan (EAMP) – Executive Summary; (b) Environmental Assessment and Management Plan (EAMP) – Main Report with Annexes; (c) Social Development Plan including a Resettlement Action Plan (RAP) and Ethnic Minorities Development Plan (EMDP); and (d) 1st Social and Environmental Management Framework and Operational Plan (SEMFO-1) for the Watershed Management and Protection Authority (including an EMDP and Resource Access Restriction Plan). In addition to these project specific studies, a large number of studies concerning planning, investments, environment, social and economic issues have been prepared for a variety of purposes at a variety of levels. Copies of selected studies will be made available to the consultant while access to studies from ADB, WBG, the Government of Lao PDR (GoL), Mekong River Commission (MRC), and other organizations will be facilitated

7. **Scope.** The scope of the study should cover spatial and temporal dimensions relevant to cumulative impacts and take into account medium- and long-term strategic planning in the project area and in the Greater Mekong Subregion. The development scenarios assessed should include all relevant sectors and key issues likely to be faced under these scenarios. The initial scoping of the CIA study, including the spatial and temporal dimensions, potential development scenarios, and key issues and questions to be answered by the study, are described below. The consultant shall use this as a starting point for further refining the scope through a consultative process.

Key issues and questions. A set of issues has been developed based on preliminary identification of the potential key direct and indirect impacts caused by the proposed project and medium and long term development in the region.

1. Hydrology;
2. Vulnerability to flooding;
3. Social issues;
4. Fisheries;
5. Water quality;
6. Transport;
7. Water supply and irrigation;

8. Urban Development;
9. Institutional issues; and
10. Biodiversity.

Additional information and further explanation of these issues to be addressed by the study is provided in Annex A.

Spatial Coverage. The CIA should evaluate potential cumulative impacts to which the project will contribute, within the following primary areas:

- Mekong River Basin;
- Nam Kading and Xe Bang Fai River Basins; and
- Linear development zone associated with the transmission lines.

This spatial coverage allows the proposed project: (a) to be evaluated in the context of current and planned developments in the upper, middle, and lower Mekong River basin; (b) to examine the cumulative impacts from current and proposed activities in the two river basins in which the proposed project will be located; and (c) to review the impacts in the zone that will be influenced by the transmission line corridor.

Within this overall spatial scope the impacts of the project may be expected to differ in the following sub-areas:

1. The Nakai-Nam Theun NBCA
 - this conservation area is sparsely settled by ethnic minority people with existing shifting agriculture and utilization of wildlife and non-timber forest products.
2. The Nam Theun River and adjacent land area
 - downstream of the proposed dam, upstream of the existing Theun-Hinboun dam and reservoir
 - in this area two Rivers i.e., Nam Niap and Nam Phao flow into the Nam Thuen
 - this area is not used for agriculture, but is an important corridor for movement of wildlife;
3. The Nam Kading and Nam Hinboun Rivers between the Theun-Hinboun reservoir and the Mekong River
 - this area is for agriculture and other land use;²
4. The Mekong River between the confluence of the Nam Kading and the Xe Bang Fai Rivers
 - flows in this river reach will be reduced due to the diversion of water from the Nam Theun to the Xe Bang Fai, this reduction in flows will generally apply to both wet and dry seasons;
5. The area of the Nakai-Plateau surrounding the project reservoir, especially those areas that will be used by people resettled from the area to be inundated by the reservoir
 - activities of the resettled peoples within this area are initially anticipated to include agriculture (including animal husbandry), community forestry and utilization of non-timber forest products
6. The area of the lower Xe Bang Fai watershed below the confluence of flow from the project
 - with a few development centers such as Mahaxai and downstream, agriculture supported by irrigation water drawn from the Xe Bang Fai is practiced in this area; and
7. The Mekong River downstream of the Xe Bang Fai.

Temporal Coverage. The CIA should evaluate potential cumulative impacts in the following time frames:

² To be confirmed by field study.

- Five Year Planning Horizon;
- Twenty Year Planning Horizon; and,

These time frames have been selected in order to cover the current and on-going planning studies undertaken at the regional, national and/or sectoral levels by the Mekong River Commission, national governments, and other organizations that use these horizons in their work. In addition, the consultant will, where possible, provide quantitative long-term projections of impacts data based on trend analyses.

Development Scenarios. The consultant will examine the induced and indirect impacts of the proposed project against scenarios of future development in the context of the spatial and temporal coverage described above.

Scenarios will be examined that are representative of alternative development paths for Lao PDR, based on existing development plans in the following sectors:

- Hydropower,
- Transport (including navigation and roads),
- Irrigation and water supply,
- Urban,
- Fisheries and agriculture,
- Mining and forestry,
- Industry,
- Social development,
- Conservation, and
- Others.

The scenarios of future development should include consideration of potential developments envisioned/proposed by major development agencies and the GoL, this should include but not necessarily be limited to ADB, WBG, MRC, bilateral development agencies, and NGOs.

Two development scenarios are anticipated:

- a scenario which represents the “business as usual” development pattern given the aggregate view of all the proposed developments within a twenty-year planning horizon, and
- a scenario that reflects “best practices” with broad policy support for environmentally and socially sensitive development.³

A risk assessment approach will be employed in examining the two scenarios considering the pattern and level of development which would lead to cumulative effects that are either significant or acceptably insignificant.

Study Results

Major outputs of the study will be

- a comprehensive understanding of the cumulative impacts of Nam Theun 2 project in a regional context, both in the project area and in the downstream riparian countries along the Mekong River
- Recommendations to relevant stakeholders to better address the identified cumulative impacts and improve their planning and programs.

C. Tasks

³ This scenario will be envisioned with the overall conditions fulfilled and enforced under ADB Loan 1867-LAO: Environmental and Social Program Loan.

Task 1. Project Initiation Meeting.

At the outset, the consultant, with endorsement from ADB, WBG, and GoL, will convene a project initiation meeting in Lao PDR to discuss the following:

- (i) methodology to be used for the study,
 - (ii) project workplan and schedule,
 - (iii) expected deliverables,
 - (iv) identification of all relevant documents to be reviewed as part of the baseline for the study,
 - (v) the scope of the cumulative impact assessment,
 - (vi) problems or constraints associated with the study, and
 - (vii) approaches to public consultation with various stakeholders including focus groups identification, interaction protocols, and documentation.
- A project initiation summary report will be prepared by the consultant.

Task 2. Prepare Baseline

The consultant will prepare an environmental and social baseline based on consolidation of available information. The consultant shall present the best available information in the form of maps, images, and land use assessments summaries. Maps are to be produced using a GIS.

The development of the baseline shall include desk reviews and evaluation of existing studies which have addressed environmental and social impacts and strategic developmental planning issues. This includes but should not be limited to: the Environmental Assessment and Management Plan; Social Development Plan; the SEMFOP; Study of Alternatives (Lahmeyer); Macro-economic study (Berger); other hydro-sector plans; cumulative effects analysis; existing or planned provincial environmental studies (IUCN 1998); social profiles conducted on behalf of government or other donors; provincial economic development plans; project specific environmental impact assessments and social assessments completed for projects in the impact area (e.g. Theun-Hinboun).

Based on the review of existing work, the consultant will recommend additional supplemental work which is necessary to complete a comprehensive and adequate cumulative impact assessment.

An institutional review of key policies/legislations/regulatory framework for environmental and social management of the GoL will also be required as part of the Baseline Information.

Task 3. Refine Scope of Study

The preliminary scope of the cumulative impacts assessment has been identified with key issues listed (Annex 1). The consultant will revise the scope using an interactive process characterized by the consultative approach identified in Task 1. The consultant will identify regional issues of concern, identify eco-systems components that are valued by different stakeholders, define the study's spatial and temporal coverage; identify other proposed activities that may affected valued ecosystem components; and identify possible impacts. Scoping should be based on a participatory approach in order to solicit comments from the project affected groups, other stakeholders and to undertake a detailed planning workshop and focus group discussions among the relevant provincial and national authorities and sectoral line agencies.

All consultations undertaken with respect to the cumulative impact assessment are to be coordinated with all consultation and participatory activities undertaken by ADB and GoL and its consultants as part of the project preparation.

The final scope of the study should be presented, with confirmation by ADB, in terms of:

- cumulative impact issues to be addressed,
- the planning horizon or time frame of the assessment,

- the spatial coverage and resolution,
- the proposed elements to be included in the development scenario, and
- indicators proposed to evaluate cumulative impacts

Task 4. Preparation of Draft Development Scenario

Preparation of two development scenarios based on a comprehensive review of planned projects and government programs including, an inventory of planned developmental programs in the project's spatial and temporal boundary area of influence for the foreseeable future. Within this, the scenarios should distinguish between actions which are certain, reasonably foreseeable and hypothetical.

Scenarios will be examined that are representative of alternative development paths for Lao PDR, based on existing development plans in the following sectors:

- Hydropower,
- Transport (including navigation and roads),
- Irrigation and water supply,
- Urban,
- Fisheries and agriculture,
- Mining and forestry,
- Industry,
- Social development,
- Conservation, and
- Others.

Two development scenarios are to be prepared and examined:

- a scenario which represents the “business as usual” development pattern given the aggregate view of all the proposed developments within a twenty-year planning horizon, and
- a scenario that reflects “best practice” with broad policy support for environmentally and socially sensitive development.

Task 5. Inception Report and Meeting

An inception report will be prepared based on the results of the previous tasks. This report will be presented and reviewed at a meeting with ADB and WBG. The Government of Lao PDR and NTEC will be briefed on the progress of the study at this stage.

An annotated table of contents for the Interim Report will be presented in the Inception Report for review and discussion at the inception meeting. Any necessary changes to project work plan and schedule will be addressed during this meeting.

Task 6. Impact Analysis

The consultant will undertake:

- Assessment of potential economic, ecological, and social trends including those potentially induced by NT2 or other regional projects.
- Evaluation of all relevant social and environmental impacts (negative and positive) of likely regional development projects and socio-economic trends including an evaluation of the indirect, long term and cumulative impacts of the NT2 project.
- As detailed in the list under Annex 1, this analysis should include but not be limited to:

- the anticipated flow regime within the affected river systems and its effects;
 - effects of any increased irrigation, fisheries and tourism development;
 - effects of the absence of development projects likely to be forgone due to NT2;
 - effects of changes in transboundary social and economic interactions with Vietnam and Thailand;
 - effects of induced development;
 - impacts on different social groups, such as ethnic minorities, women, youth, elders and other vulnerable or marginalized groups;
 - the role of governance issues such as corruption, elite capture and inequity that may constrain development efforts or may be aggravated by development efforts;
 - identification of institutions likely to enhance or constrain development efforts particularly concerning equitable opportunities and sustainability;
 - impacts on land tenure and land use practices, including those specific to ethnic minorities;
 - evaluation of the various stakeholder interests (national, regional and local), their influence and implications for the selection and implementation of regional projects and policies.
 - potential synergistic effects among the regional trends and projects, including NT2.
- Identification of the major social and environmental risks and challenges of long term development in the area of influence.
 - Evaluation of strategic alternatives for long term development in the region, specifying: benefits (including allocation among groups and geographic areas), constraints; implementation and financing options; and costs.
 - Evaluation of the adequacy and constraints of the legal and institutional framework in Lao PDR for addressing induced and cumulative effects.

Task 7. Interim Report and Meeting

An interim report will be prepared based on the impact analysis. Recommendations for NT2 project-related activities to better address the cumulative impacts of the project, if any, should be included in the interim report. In addition to describing the potential cumulative impacts, the report should evaluate the implications for future development. The suggested contents for the interim report are provided in part D below. Upon completion of this task, the consultant will have a technical meeting with ADB, WB, GoL and the developer. An annotated table of contents of the final report will be presented and agreed to at this meeting. Consultation workshops should be undertaken at this point in order to solicit comments from the project affected groups, other stakeholders and to undertake a detailed planning workshop and focus groups discussion among the relevant provincial and national authorities and sectoral line agencies.

Task 8: Conclusions and Recommendations

Based on the outcome of the previous tasks, the consultant will outline the following as part of the conclusions and recommendations in the report:

- The major cumulative impacts of Nam Theun 2 project in a regional context, both in the project area and in the downstream riparian countries along the Mekong River
- Recommendations for NT2 project-related activities to better address the cumulative impacts of the project, if any (this task should be completed within 4 months after commencement and recommendations should be included in the interim report);

- Recommendations to relevant government agencies including sectoral agencies, WMPA, district and provincial governments in their future planning and programs.
- Recommendations for riparian countries, donors and the Mekong River Commission on current and future activities in the affected areas of the Mekong River Basin.

Task 9. Finalize Report.

The objective of this task is to finalize the CIA report, incorporating the results of the consultation and ADB and WBG comments.

The consultant shall:

- (i) provide documentation on the results of the consultation with stakeholders;
- (ii) revise the draft report based on the agreed table of contents and the results of the consultation;
- (iii) include as part of the revised draft final report, how the document was influenced by the consultation process including specific examples;
- (iv) provide the revised draft final report to the ADB and WBG for review; and;
- (v) incorporate ADB and WBG comments into the report and provide documentation on how the final report responds to ADB and WBG comments.

Task 10. Assist the Government of Lao PDR in Public Consultation Program, Including Disclosure of Project Related Documents and especially CIA study to the Public.

Through the study the consultant will assist the GoL to disclose project related documents and CIA study information to the public.

The consultant shall:

- assist the GoL in implementing its public consultation process as part of the existing project public consultation program, including supporting the posting of information on the project website for public access and receiving comments and requests for information at the scoping stage and interim final report stage;
- support the GoL in dissemination of printed copies of the draft and final versions of the CIA in key locations within the various levels of the study area; and
- the draft and final Executive Summary and Main Report will be disclosed in English, Lao, and Thai.

D. Reports

The consultant will provide ADB with the following reports:

Inception Report (20 copies) The inception report should be prepared after preparation of the Baseline, Scoping and draft development scenarios (Tasks 2-3). The report should describe: (i) the detailed baseline analysis; (ii) the scope of the CIA analysis including the spatial and temporal scales, the key issues and questions to be addressed and types of conclusions; and, (iii) detailed draft development scenarios. It should also present a very brief overview of difficulties in achieving the work as described in the contract, proposed alternate means to achieve the Project objectives, status of budget and major scheduled milestones, and any proposed modifications to the contract mandate. The report will be presented and discussed in a meeting with the ADB and WBG.

Interim Report (20 copies) The interim report should be prepared after the impact analysis (Task 6) is completed. It should provide the detailed analysis of the cumulative effects of the project under the development scenarios. An annotated outline of the draft CIA report consisting of a full table of contents should be presented, complete with chapter titles, annex titles, numbering format, main author responsible for each section, main technical issues to be addressed in each section, issues that require clarification or cooperation for each section, type of input to each section, and approximate page length for each section. The report should also provide a brief overview of difficulties in achieving the work as described in the contract, proposed alternate means to achieve the Project objectives, status of budget and major scheduled milestones, and any proposed modifications to the contract mandate. The report will be presented and discussed in a meeting with the ADB and WBG.

CIA Draft Final Report- Executive Summary, Main Report and Annexes (20 copies) The Preliminary Draft CIA Final shall be submitted to the ADB according to the time schedule set out below. This report should provide the details of baseline analyses, scoping, development scenarios, impacts analysis, and conclusions. The Executive Summary should indicate community/agency consultations undertaken. In addition to text, the Executive Summary should contain tables, figures and/or GIS maps as needed. The Main Report should focus on the analyses undertaken and preliminary conclusions supported by summaries of the analyses. Liberal use of tables, maps and graphics to present summaries of data and analyses are strongly encouraged. Detailed or un-interpreted data should be presented in annexes or a separate volume. Unpublished documents that are not readily available should also be assembled in an annex. The Draft Final Report should be delivered to the ADB and presented for discussion in a meeting with ADB and WBG. It will be disclosed to the public by posting it on the Project website and making it available at appropriate locations in printed form. The Executive Summary of the Final Report will be made available in English, Lao, and Thai; the Main Report of the Final Report will be in English. The consultant will undertake consultation with GoL and local stakeholders on the document. The results of the consultation workshops, including attendance, questions asked and issues discussed will be documented.

Final Report – Executive Summary, Main Report and Annexes (30 copies) The Final Report should be submitted within the time schedule set out below. The Final Report should provide complete details of all work performed, analyses made and conclusion. This report will integrate comments received from ADB and WBG, including issues raised and discussed at review meetings, as well as written comments. The Final Report should be delivered to the ADB and be disclosed to the public by posting it on the Project website and making it available at appropriate locations in printed form. The Executive Summary of the Final Report will be made available in English, Lao, and Thai; the Main Report of the Final Report will be in English. In addition, a master hard copy and master soft electronic copy suitable for reproduction purposes should be provided to the ADB and WBG to meet any future needs for reprinting.

E. Consultant Supervision and Time Schedule

The work of the consultant will be supervised by the ADB, which will be the focal point for coordination with the GoL, the WBG, and other regional agencies such as the MRC. The ADB will assure the consultant free access to all existing data and to all relevant operations and facilities. It will also provide liaison and contacts with the government, academic and applied research institutions and NGOs, among all stakeholders.

The following is the time schedule for the production of the reports described above. The consultant should begin work upon contract signature. The consultant should propose a clear schedule with critical milestones, and make all possible efforts to meet the proposed time schedule.

Table 1: Indicative Schedule for Cumulative Impact Assessment

MILESTONES	WEEKS TO COMPLETION
1. Contract signature	0
2. Project Initiation Meeting	2
3. Submit Inception Report with Input from Scoping Discussion	5
4. Meeting to review Inception Report	6
5. Submit Interim Report	16
6. Submit Draft Final Report	24
7. Submit Final Report	28

F. Staffing and Experience of the Consulting Firm

It is anticipated that the consultant will consist of a team of eight international specialists. It is envisaged that one of these specialists will concurrently serve as the CIA Team Leader. The inputs of all specialists should be clearly indicated in the work plan to be carried out by individuals experienced in their professional fields and aligned with the tasks assigned.

The Team Leader (an addition 2 person-months) should have at minimum 10 years professional experience in major infrastructure projects. (S)he should have experience with studies of equivalent size projects, demonstrated ability to work with government officials, civil society organizations, NGOs and the public at large, and should have a proven track record on managing and coordinating a diverse group of professionals.

The consultant should name individuals to participate in specified roles within the project team and provide full curricula vitae and any other information considered relevant by the consultant. The consultant should name the Team Leader, team members and provide an assurance that all members of the proposed team will be made available as specified in the proposal, if the consultant is selected.

Expertise needed to undertake this study is anticipated to include

- Aquatic ecologist – knowledgeable with respect to aquatic ecology, fish, and fisheries (2 person-months);
- Terrestrial ecologist – knowledgeable with respect to terrestrial fauna and flora, forestry, and forest uses (2 person-months);
- Hydrologist (2 person-months);
- Health specialist – with HIV/AIDS/anti-human trafficking specialties (2 person-months);
- Social specialist – ethnic minorities and indigenous people specialty (2 person-months);
- Agriculture/Irrigation specialist (2 person-months);
- Geographic Information System (GIS) specialist (2 person-months); and
- Senior planner – development specialist (2 person-months).

APPENDIX B: CONSULTATION PROCESS

TECHNICAL REVIEW MEETINGS

The work with the Cumulative Impact Analysis Report has involved a process of consultations with key stakeholders. Apart from separate meetings and discussions the Technical Review Meetings (TRM), arranged in connection with the submission of the Inception, the Interim and the Draft Final Report, provided perhaps the most important arena for informing the stakeholders as well as soliciting comments on the Reports. In the following a resume of the 3 TRMs is given.

Inception Report Technical Review Meeting

List of Attendants	
Organisation / Agency	Representative
Ministry of Industry and Handicrafts	Mr. Houmphone Boulyaphol, Director General, Department of Electricity Mr. Chantho Milattanapheng, Chief of Division, Social and Environmental Management Division
Nam Theun 2 Project Office, Prime Ministers Office	Dr. Maydom Chanthanasing, Director, Nam Theun 2 Project Office
Asian Development Bank	Mr. Shih-Liang Tu, Environment Specialist, Infrastructure Division, Mekong Department Mr. Edvard Baardsen, Deputy Head of Lao Resident Mission Mr. Sadiq Zaidi, Advisor to the NT2 Project Team
The World Bank	Mr. Benoit Laplank, Consultant Mr. John Morton, (on phone) Environmental Engineer, Environmental and Social Development Unit
Nam Theun Power Company	Mr. Francois Obein, Environmental Manager
Ministry of Agriculture and Forestry	One representative
Science Technology and Environment Agency (STEA), Prime Ministers Office	Mr. Phouvong Luangxaysana, Director of EIA Division, Department of Environment
Lao National Committee for Energy (LNCE)	Xaypaseuth Phomsoupha, Chief of Bureau of the Secretariat
The Water Resource Coordination Committee	Mr. Chanthanet Boualapha
Lao National Mekong Committee	Mr. Sourasay Phoumavong, Deputy Director General
Lao Front for Construction	Mr. Viengkhone
Lao Women Union	One representative
GMS Power	Mr. Robert Kay
Theun-Hinboun Power Company (THPC)	Mr. Robert Allen
Royal Cambodian Embassy, Lao PDR	One representative
Agence Francaise de Developpement (AFD)	Mr. Andre Pouilles-Duplaix, Country Director
Care International	Mr. Michael Bolton
The World Conservation Union (IUCN)	Ms. Kelsey Saek

EcoLao / NORPLAN	Mr. Gary Oughton, Irrigation Specialist Mr. Erik Børset, Teamleader Mr. Jens Laugen, Development Planner Dr. Stephen Sparkes, Ethnic Minority Specialist
------------------	---

Summary of Recommendations and Comments

Mr. Houmphone Bolyaphol opened the meeting on behalf of the Department of Electricity, the host Government Agency for the Nam Theun 2 Cumulative Impact Assessment study. Mr. Erik Børset, teamleader for the study, presented the Inception Report. The ensuing discussion session raised a number of issues and gave valuable advice and direction to the Consultant. The main points are summarised in the following.

- The analytic approach and proposed focus CIA study was in general endorsed. This involved narrowing down the scope to consider a few important development sectors and issues. These included hydropower and the effects on flooding, fish production and aquatic biodiversity.
- It was generally agreed that the study should address impacts on the Tonle Sap and the Mekong Delta in terms of fisheries, salt intrusion etc.
- It was advised that the study should distinguish clearly between effects caused by the NT2 Project and other hydropower project, for instance in Yunnan, China. One expressed opinion in this connection was that the planned hydropower projects in China would have a profound effect on the water-flow regime in the Mekong and therefore needed to receive more focus than NT2.
- The mining sector was emphasized as a sector that could have effects on the water quality and therefore needed to be focused in the study.
- The issue of notification of the downstream riparian countries of Thailand, Cambodia and Vietnam was raised and the Lao National Mekong Committee informed that their Cambodian counterpart had been invited to visit the NT2 Project. No visit had, however, been scheduled yet.
- The issue of economic quantification of impacts was raised and it was suggested that the study should try to quantify the effects of changed flow regimes and other effects in all the affected river basins. In this connection it was recommended that the study also should focus on also the positive impacts as far as possible.
- One of the potential positive impacts of NT2 that was mentioned was the increased employment opportunities and the potential for training and qualification of young people.
- The issue of a possible concentration of skilled administrative and technical manpower in connection with the NT2 was discussed and it was advised that the CIA study should, if feasible, try to assess the danger of a “brain drain” effect.
- Social impacts on the local level such as the price of land, increased crime etc, was mentioned as an important effect to consider, but doubts were expressed if the CIA should consider direct impacts like these.
- The issue of what time perspective to apply in connection with the 5 and 20-year scenarios was raised, that is, what year in the project development process should be used as a point of departure.
- It was emphasised that the CIA study should not repeat work and studies already completed but build on all previous relevant studies.

- It was advised that the study should consider institutional coordination arrangement on riparian or basin level and give advise on a strengthening of these.
- It was expressed that the CIA study could give answer to some of the concerns raised by Cambodia.
- In relation to the time dimension of impacts it was mentioned that some impacts are negative on the short-term but will become positive on the longer term. Therefore the study needs to take this factor into consideration.
- Finally, reassurances were given by the ADB that the support for the NT2 Project would not be conditioned on the outcome of the CIA Study but that the results would form part of the Summary Environmental Assessment.

Interim Report Technical Review Meeting

List of Attendees	
Organisation / Agency	Representative
Ministry of Industry and Handicrafts	Mr. Houmphone Boulyaphol, Director General, Department of Electricity Mr. Chantho Milattanapheng, Chief of Division, Social and Environmental Management Division
Nam Theun 2 Project Office, Prime Ministers Office	Dr. Maydom Chanthanasing, Director, Nam Theun 2 Project Office
Asian Development Bank	Mr. Shih-Liang Tu, Environment Specialist, Infrastructure Division, Mekong Department Mr. Edvard Baardsen, Deputy Head of Lao Resident Mission Mr. Sadiq Zaidi, Advisor to the NT2 Project Team Ms. Marla Huddleston, Mekong Department,
The World Bank	Mr. John Morton, Environmental Engineer, Environmental and Social Development Unit Mr. Robert Mertz, Lead Financial Analyst, Energy and Mining Sector Unit
Nam Theun Power Company	Mr. Francois Obein, Environmental Manager
Lao National Committee for Energy (LNCE)	Xaypaseuth Phomsoupha, Chief of Bureau of the Secretariat
Science Technology and Environment Agency (STEA)	Mr. Phouvong Luangxaysana, Director of EIA Division, Department of Environment
Agence Francaise de Developpement (AFD)	Ms. Emilie, Durochat
EcoLao / NORPLAN	Mr. Gary Oughton, Consultant Mr. Erik Børset, Consultant Mr. Jens Laugen, Consultant

Summary of Recommendations and Comments

Mr. Shih-Liang Tu opened the meeting. He invited NORPLAN to make a presentation of the CIA Interim Report and its preliminary findings. Mr. Erik Børset and Mr. Jens Laugen presented the report. The following comments and advises were given:

- The figures and calculation of hydrological impacts of the NT2 Project and resulting losses of fish production in the Tonle Sap need to be scrutinized and checked to make sure that they are reasonably accurate and realistic.
- Potential positive impacts of the NT2 project for instance on fish production, agriculture and reduced flood damages need to be examined, quantified and presented as total cumulative impacts together with negative fish production impacts as a counterbalance.
- The Cambodian and Vietnamese National Mekong River Committees should be invited to Lao PDR and information shared on predicted downstream impacts when there is agreement on the CIA report amongst GOL, NTPC, ADB and the WB.
- References to where in the Impact Zones hydrological impacts and changes are expected to occur need to be specific.
- Some more attention should be given to livelihood and agricultural development on the Nakai Plateau and the risks that some of the resettlers may not be able to establish adequate livelihoods.
- The CIA study should look into the issue of compensatory forestry and give recommendations for future legal and policy frameworks.
- There are inconsistencies in the scenario descriptions concerning urban development, health, employment, etc. that should be corrected;
- The issue of STIs and HIV/AIDS need to be addressed more thoroughly and seriously, especially in the 20-year scenario description.
- A distinction should be made in the 20-year scenario descriptions between 'business as usual' and 'best practice'.
- The issue of migration and urbanisation and should be addressed more thoroughly in the context of poverty.
- The scenarios on institutional capacity and development contain inconsistencies that need to be reconciled.
- It is recommended that the CIA also address the issue of revenue for the government institutions.
- It should be considered to address the issue of institutional capacity in a quantitative way by looking at staffing and structure.
- It is important that the results of the Riparian and the Xe Bangfai studies done by NTPC are incorporated in CIA study.
- The CIA study needs to assess the resource concentration effect of the NT2 Project.
- The cumulative impacts should be ranked as far as possible in terms of significance.
- Recommendations in the Final report should focus on policy and institutional issues.
- The issue of assimilation of ethnic minority should be looked at again.

Draft Final Report Technical Review Meeting

List of Attendees	
Organisation / Agency	Representative
Ministry of Industry and Handicrafts	Dr. Somboun Manolom, General Director of Cabinet Mr. Houmphone Boulyaphol, Director General, Department of Electricity Mr. Chantho Milattanapheng, Chief of Division, Social and Environmental Management Division
Nam Theun 2 Project Office, Prime Ministers Office	Dr. Maydom Chanthanasing, Director
Lao National Committee for Energy (LNCE)	Xaypaseuth Phomsoupha, Chief of Bureau of the Secretariat
Asian Development Bank	Mr. Woonchung Um, Principal Operations Specialist, Infrastructure Division, Mekong Department Mr. Shih-Liang Tu, Environment Specialist, Infrastructure Division, Mekong Department Mr. Edvard Baardsen, Deputy Head of Lao Resident Mission Mr. Sadiq Zaidi, Advisor to the NT2 Project Team
The World Bank	Mr. Benoit Laplank, Consultant Mr. P. Illongo
Nam Theun Power Company (NTPC)	Mr. Bernard Tribollet, CEO Mr. Bertrand Daubord, COO Mr. Francois Obein, Environmental Manager
Cambodia National Mekong Committee	Mr. Te Navlith, Deputy Secretary General
Ministry of Water Resources and Meteorology - Cambodia	Mr. So Im Monichoth, Chief, Research and Flood forecasting Office, Department of Hydrology and River Works
Royal Embassy of Cambodia, Lao PDR	Mr. Sam Than, Counsellor
Mekong River Commission Secretariat	Mr. Hans Guttman, Programme Coordinator, Environmental Division
Agence Francaise de Developpement (AFD)	Mr. Victor Paulin, Acting Country Director
EcoLao / NORPLAN	Mr. Erik Børset, Consultant Dr. Stephen Sparkes, Ethnic Minority Specialist

Summary of Recommendations and Comments

Mr. Woonchung Um welcomed all and stated that the CIA is not just a study of NT2 but also of the regional development context. The NT2 Project is a pilot case for the development of the CIA study for ADB and CIA will become a requirement for all large ADB projects in the future. The technical review meeting form part of the consultative process, including consultations with downstream country like Cambodia.

Mr. Somboun Manolom welcomed those attending the workshop on behalf of the Government of Lao (GOL) and emphasised the importance of NT2 for the future development of the country as a whole, especially in terms of providing funding for poverty alleviation programmes. The preparation and planning for NT2 has been extensive and in conformity with bank safeguards. The consultation process is an important part of the process, including cooperation with Cambodia. Comments, advice and suggestions were encouraged from all attending this workshop.

Mr. Shih-Liang Tu gave the background to the study which deals with NT2 in the regional development and 5 and 20-year scenario (temporal dimension) context. The report is primarily based on secondary data from other reports and covers a range of fields, not just hydropower. The goal of this Workshop is to elicit comments from all stakeholders in order to finalise the CIA Report.

Mr. Te Navliith said that the Cambodian government and CNMC have been following closely the progress of NT2 and were especially concerned with issues related to Tonle Sap, including fisheries, irrigation, biodiversity, flood retention and protection from salt intrusion. The goal of attending this workshop was to understand more about the findings of the CIA and to report back for further discussions.

Mr. Hans Guttman emphasized, in his opening comments for MRC, emphasised the importance of cross-boundary issues for MRC and considered the involvement of Cambodia at this stage in planning as positive.

During the ensuing presentation of the Report by NORPLAN a number of questions and issues were raised and discussed. These are summarised in the following:

- There are no hydropower development and large-scale irrigation projects planned in the Mekong Basin part of Thailand.
- Impacts of irrigation on water regimes and flow pattern are considered minor thus only hydropower is included in the modelling of impacts.
- The 8% reduction of flow for the 1950-2000 period is incorporated in the calculations for the 5 and 20-year scenarios.
- It is important to underline that the 3 – 4 cm predicted reduction on wet season flow level in the Tonle Sap is very minor against 7-8 difference throughout the year.
- The possibility of water transfers from Lao PDR to Northeast Thailand has been considered unlikely because of technical and economical aspects.
- Flood reduction has been considered an important factor of the NT2 impacts while the dry season flow reduction between Pakkading and Xe Bangfai of 3-4 cm is considered insignificant in relation to irrigation pumping costs.
- The production of fish in the Tonle sap is dependant on the fluctuation in flow level between wet and dry season and permanent flooding will therefore be a negative impact. The Report should also have to cover the biodiversity aspects and the impacts on the Khone Falls/Siphandon and other areas defined in the Ramsar Convention on Wetlands.
- There are many factors that will influence developments in Tonle Sap which will be difficult to distinguish from the NT2 impacts.
- Stabilisation and regulation of the flow in the Mekong might be a benefit for the human population in terms of hydropower and irrigation but not necessarily good for the biodiversity.

- The very marginal positive impacts on flood control and salt intrusion up to Phnom Penh can be seen as a trade off against the very marginal impacts on fisheries and biodiversity.
- There will be small impacts on water flow but there is a danger that the 10% of the impacts that can be ascribed to NT2 is seized upon by some critics. It is however difficult to determine which project is the one that “makes the water flow over the edge of the glass”. A cost benefit analysis to determine which projects from an economic point of view are the best is also problematic. Judged according to the relationship between active storage and electricity production NT2 comes out well.
- Findings from the MRC study on climate change could enhance the hydrological modelling. The finding of the study indicate that the rainfall has remained constant for the 1950-2000 period and that there must be other causes for the reduction of flow in the Mekong.
- The impacts predicted for the Nakai Plateau and the Xe Bangfai also includes the NT2 induced impacts and other sector developments such as transport which is considered one of the most important sectors.
- The projected increase in HIV/AIDS in the Project area is both a result of the general trend and increase in the country and the result of transportation corridors, new settlement, increased mobility, border areas as well as the success of awareness and prevention programmes. The contribution of NT2 only is very difficult to quantify.
- The conclusions on fisheries are preliminary and cautious. This is because the summary combines different rivers, but the overall impact will be negative.

In the discussion following the presentation of the Report a number of issues were raised and clarifications made. The most important are reumed in the following:

- It is recommended that China becomes a member of the MRC but it is not considered probable for the time being. It would however be important to have a dialogue and cooperation on minimising the negative impacts.
- It is very difficult to go beyond the 20-year scenario and include 50 and 100-year scenarios when it comes to hydropower development. However, 100-year minimum and maximum floods can be calculated and included in the analysis in order to show extreme hydrological situations and their impacts.
- More information on water quality could be included in the report, especially in relation to reduced sediment loads and increased pollution from urbanisation. It would also be interesting to include impacts of management options. MRC presently has an ongoing water quality monitoring programme and is also working on principles for basin flow management.
- It was commented from the side of the World Bank that the CIA was a good report that has allied concerns about the extent of downstream impacts as well as addressed regional issues. The recommendations, however, need to be strengthened, for instance in relation to the use of the NT2 as a model for other hydropower development projects in the future.
- From the Government's side it was commented that the CIA Report was very important for Lao PDR and should function as a planning tool. There was a concern that NGOs might misuse the information. The CIA is a new kind of study and in accordance with requirement of the donors the NT2 Project is more open and transparent than previous projects in Lao PDR. Furthermore, in relation to hydropower development plans NORPLAN should refer to a 1988 ADB-funded study on potential hydropower development for Cambodia. In addition, NORPLAN should reconsider the 14 proposed hydropower projects listed for Lao PDR in the 20-year scenario. It is very uncertain that all of these projects will be developed since they depend on private investment.

- There was a general agreement that the CIA Report should be disclosed and become available for NGOs and the public.
- On the issue of cost benefit analyses it was concluded that some impacts were difficult to quantify, such as effect on fisheries, because of lack of data and a multitude of influencing factors.
- From the Cambodian side more detailed information on the changes in fluctuation in the Great Lake like differences between the maximum and minimum flows and the duration of the inflow and outflow, was requested. It was also emphasized that the letter the Cambodian National Mekong Committee submitted outlined the concerns raised in the different technical ministries. The Committee facilitated the process but the comments belonged to the government ministries. The 10 points raised were for clarification, not for further studies.
- In relation to biodiversity it was recommended that the ADB Strategic Environmental Framework (SEF), which identified a number of environmental 'hotspots' in terms of biodiversity importance and vulnerability, should be mentioned in the report.
- It was recommended that one should emphasise the fluctuation aspect of the Great Lake as the importance appeared to be in the difference between the maximum and minimum flows and the timing of the in and outflows. It was acknowledged this aspect was calculated in the 20-year scenario in the Hydrology Annex but that the effect of NT2 only also would be interesting.
- It was commented that Integrated Water Quality Management is in the process of being approved at the national level but that there is a lack of framework for water use designation and corresponding standards for agriculture, NBCAs, urban areas, etc. In general, the water quality in the Mekong is good, except for perhaps in the Delta area during the dry season. There are very few spots with high levels of toxicants and chemicals.
- From the Cambodian side it was informed that hydropower development plans can be found in the Ministry of Industry, Mines and Energy. This should be the best source of information for the most up-to-date plans. Cambodia practices 'Notification' about all projects, as the Vietnamese did for Se San 4 and Pleikrong.
- With regard to notification it was informed that the Lao National Mekong Committee is discussing the matter with their Cambodian counterpart, CNMC. The Ministry of Foreign Affairs (GOL) is also in touch with its counterpart in Cambodia. The GOL view is that the first letter from CNMC does not reflect the official view of the Government of Cambodia. However GOL acknowledges the concerns raised in the correspondence.
- ADB commented that with regard to the Notification issue, technical review workshop was one of the most important meetings in the process while the CNMC commented that the MRC Secretariat is the proper channel for comments from the national Mekong River Committees.
- It was further acknowledged from the CNMC that there could be positive impacts in terms of reduction of peak flooding in the wet year but at the same time it was emphasised that there would be a negative affect in dry years. What should be highlighted in the 5 and 20-year scenarios, was the negative impact in terms of area covered. For the 5-year scenario, there was a predicted loss of up to 375 sq. km, an area almost equal to the NT2 reservoir. For the 20-year scenario, it could be as much as 9,000 sq. km, an area equal to the catchment of the NT2 dam. The reduction in the circumference of the lake will be very significant.
- It was commented that it would be important to emphasize that the scenarios included all hydropower developments, not only the effect of the NT2. It was

therefore agreed that the Report should be titled: “Cumulative Impact Analysis and Nam Theun 2 Contribution”.

- It was inquired about the feasibility of predicting and calculating impact on fisheries as it would be important to demonstrate and calculate losses in connection with entitlement for compensation. It was informed that collection of baseline data were ongoing as a part of other studies such as the Riparian Release Study and the new Xe Bangfai Report.
- It was informed that MRC will comment on the CIA in writing if requested formally by ABC. It was confirmed that a formal request would be forthcoming.

PEOPLE MET AND CONSULTED

Organisation/Agency	Name/Position
Department of Environment, Science Technology and Environment Agency (STEA)	Mr. Soukata Vichit, Director general, Department of Environment Mr. Phouvong Luangxaysana, Director of EIA Division
Department of Industry and Handicraft – Khammouane Province	Mr. Viseth Khotsouvanh
Department of Irrigation, Khammouane Province	Mr. Southone, Chief of Office
Department of Planning and Cooperation, Khammouane Province	Mr. Sisouvane Siphanesay, Planner
Department of Transport, Khammouane Province	Mr. Noupak Tjantjampha, Chief of Office
Embassy of Sweden, Vientiane	Mr. Claes Kjellström, First secretary Mr. Sombath Southivong, Programme Officer
Empowerment of Local Communities in Remote Upland Watershed Project (ECRU)	Mr. Maniveng Phetoudom, National Project Director
Gnommalat District Administration	Mr. Langsi Vongsuthi Chief of Office
IUCN, Vientiane	Mr. Peter-John Meynell, UNDP Programme Team Leader. Mr. Alvin Lopes, Wetland Ecologist
Lao National Committee for Energy (LNCE)	Mr. Xaypaseuth Phomsoupha, Chief of Bureau of the Secretariat
Lao National Mekong Committee	Mr. Phetsamone Southalack, Director, Planning and Cooperation Division Mr. Sourasay Phoumavong, Deputy Director General
Lao-Swedish Upland Agriculture Forestry Research Programme, NAFRI	Mr. Carl Gustav Mosberg, Senior Programme Management Advisor
Mekong River Commission Secretariat, Phnom Penh and Vientiane	Mr. Hans Guttman, Programme Coordinator, Environment Division. Ms. Charlotte MacAlister; Aquatic Ecosystems, specialist, Environment Division.

	<p>Mr. Chris Barlow, Manager, Fisheries Programme. Mr. Minoru Kamoto, Expert on River Management, BDP Ms. Petrina Rowcroft, Development Economist, BDP. Ms. Nouanedeng Rajvong, Water Resources Development Planner, BDP. Mr. Solieng Mak, Environment/Natural Resource Planner, BDP</p>
Ministry of Agriculture and Forestry	Mr. Somchit Thongphanheuangsy, Director, Technical Division – Department of Irrigation
Ministry of Communication, Transport Post and Construction (MCTPC)	Mr. Samone Vimany, Deputy Director, Department of Housing and Urban Planning
Ministry of Industry and Handicraft (MIH)	<p>Mr. Houmphone Boulyaphol, Director General, Department of Electricity Mr. Chantho Milattanapheng, Chief of Division, Social and Environmental Management Division</p> <p>3) Mr. Virasack Chundara, Acting Director, Division of Industrial Environment</p>
Programme Facilitation Unit, UNODC	Mr. Leik Boonwat, Senior Advisor
Secondary Towns Urban Development Project, Department of Housing and Urban Planning, MCTPC	Mr. Thenekham Thongbonh, Project Manager
Sustainable Forestry and Rural Development Project, NAFRI	Mr. Tomas Jonsson, Chief Technical Advisor
Technical Assistance to the Small Towns Development Sector Project, MCTPC	Mr. Leif Oxheden, Teamleader
Thakek Urban Development Administration Authority (UDAA)	Mr. Chanpheng Philachanh, Vice President of UDAA
The World Bank, Vientiane	Mr. Viengkeo Phetnavongxay, Operation Officer Rural Development
UN Inter Agency Project on Human Trafficking, Vientiane	Mr. Sverre Molland, Project Advisor
Wildlife Conservation Society (WCS)	Mr. Michael Hedemark, Country Programme Co-director

